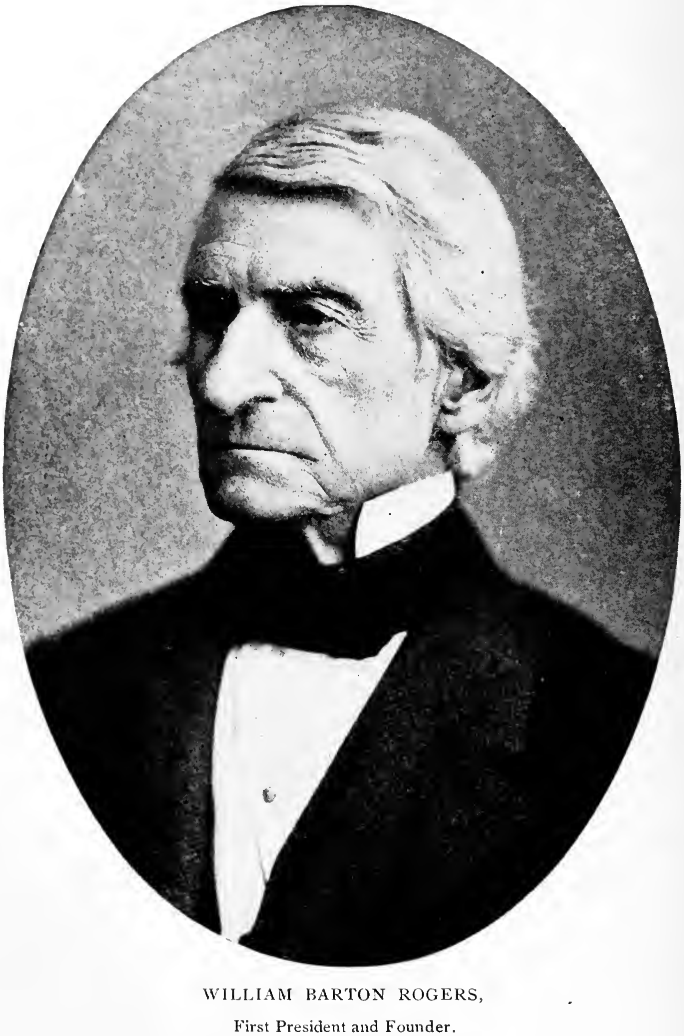

WILLIAM BARTON ROGERS,

First President and Founder.

The Massachusetts Institute of Technology

A BRIEF ACCOUNT OF ITS FOUNDATION, CHARACTER, AND EQUIPMENT

BOSTON

PUBLISHED BY THE INSTITUTE FOR USE AT THE ST. LOUIS EXPOSITION

HENRY S. PRITCHETT, PH.D., LL.D.,
President.

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COURSES OF INSTRUCTION.

THE Massachusetts Institute of Technology is a scientific school, or college, of industrial science, in which are taught the sciences and their applications to useful arts. The studies, exercises, and experiments of the school are grouped in thirteen four-year Courses, enumerated below. The work of these Courses is supplemented by graduate Courses, summer schools, and the Lowell School for Industrial Foremen.

I. Civil Engineering, including Railroad and Highway Engineering, Bridge Construction, and Hydraulic Engineering.

II. Mechanical Engineering, including Steam Engineering, Locomotive, Mill, and Marine Engineering, and Heating and Ventilation.

III. Mining Engineering and Metallurgy.

IV. Architecture, including Design, Construction, and Landscape Architecture.

V. Chemistry, with Five Options.

VI. Electrical Engineering.

VII. Biology.

VIII. Physics, with an Option in Electro-chemistry.

IX. General Science.

X. Chemical Engineering.

XI. Sanitary Engineering.

XII. Geology.

XIII. Naval Architecture.

The
Massachusetts Institute of Technology

BOSTON, MASSACHUSETTS.

THE Massachusetts Institute of Technology was opened to students in the year 1865, four years after the granting of the charter to Professor William Barton Rogers, its first President, and his co-workers. The original plan of President Rogers made provision for a "comprehensive, polytechnic college" which should provide a "complete system of industrial education." The element of manual training was added in 1877 by President Runkle, as a result of an exhibition in Philadelphia of the results obtained in Russia by instruction of this kind. President Rogers further proposed that provision be made for evening lectures, for the benefit of the public, and also for the establishment of a society of arts to serve as a medium for the announcement of scientific discoveries and inventions. The first part of this proposition is represented in the present Lowell School for Industrial Foremen; the second part, in the Society of Arts, for a long time the governing body of the Institute, and now an important means of stimulus to its intellectual life.

Foundation.

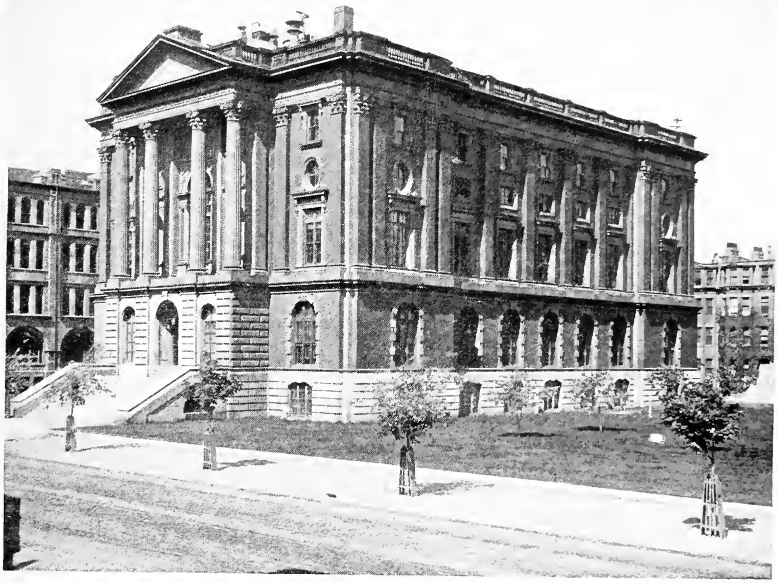
The connection of the Institute with the State has been marked by a generous grant of land in what is now a central position in Boston. The State has aided the Institute also by a gift of $100,000, by a fund of like amount for scholarships, and by an allotment of one-third of the national grants to the State under the Acts of 1862 and 1890. Since 1895 it has added a gift of $25,000 per annum. The larger part of the endowment of the school is, however, derived from gifts by private individuals. It is somewhat inadequate considering the high cost of scientific education; but the

increasing reputation of the Institute and the recent large bequests of Henry L. Pierce, Edward Austin, and others make a brighter outlook for the future.

THE Massachusetts Institute of Technology is a Scientific School or College of Applied Science. With a view to preparing its graduates for future usefulness in various professions, it aims to provide both broad general education and specific technical training. While the applications of the sciences to the useful arts are taught in the Institute of Technology, the primary purpose of the school is education. Not only are mere rule of thumb and technical methods constantly subordinated to the acquisition of principles, but those principles are studied with the predominant purpose to expand and develop the mind, to exercise the powers, and to train the faculties of the pupil. In the four years required for graduation, it is sought to make the pupil observant, discriminating, and exact,— in short, a well-educated man, in the truer sense of that term. As one means to this end, the Faculty of the Institute has uniformly maintained that some proportion of philosophic study should be combined with scientific work. Accordingly, in every Course, for at least three years out of the four, such "liberal studies" as history, political economy, and English composition and literature are made part of the requirement for graduation.

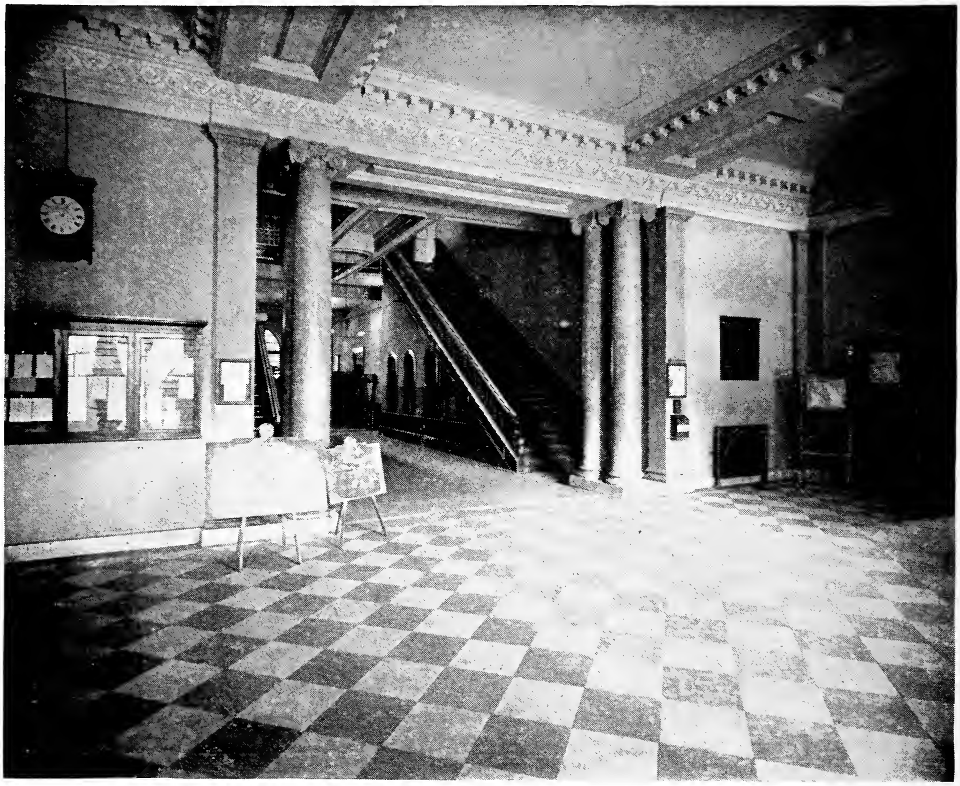
Purpose of the School.

The chief purpose of the Institute, meanwhile, is to turn out graduates who have studied the scientific principles governing some one field of work, and have had a certain amount of practice in the application of these principles to some one technical profession. Every student at the Institute is expected first to master the fundamental principles of mathematics, chemistry, and physics, which underlie the practice of all the scientific professions. He is then made familiar with the special problems of the profession at which he individually aims. His work should issue in a combination of theoretical and practical knowledge. It should develop in him a taste for research and experimentation on the one side and for active exertion on the other. Especially it should qualify him



ROGERS BUILDING.

ENGINEERING AND PIERCE BUILDINGS.



CORRIDOR, ROGERS BUILDING.

immediately upon graduation to take a place in the industrial order. How far this object has been attained through the instruction given in the Institute, the roll of its alumni with their occupations will show. As a rule, graduates of the Institute readily find professional positions where they have an opportunity to show what is in them, and to work their way upward as fast as they deserve. As a rule, also, the course of the graduate of the Institute is one of steady and even rapid promotion.

Standard of Scholarship.

A high standard of scholarship has from the first been maintained. The success of the Institute, and the number of its graduates, show good grounds for the belief, in which the school was founded, that if young men are properly appealed to, and given work which they themselves see to be worth doing, they can be brought to labor with energy and enthusiasm; and that lowering the standard of requirements is not the way to make a school popular, any more than it is the way to make it useful.

Students at the Institute.

BY the catalogue of 1903–1904 the number of students at the Institute is 1,528, and the number of teachers 227,—a total which makes it the largest scientific and technical school in the United States, and one of the largest in the world. This great body of students comes from forty States and two Territories of the Union, and from over twenty foreign countries. Among them are found about one hundred and seventy graduates of other colleges and scientific schools. Such students may usually, by proper arrangement of their previous studies, complete the Institute course in two years.

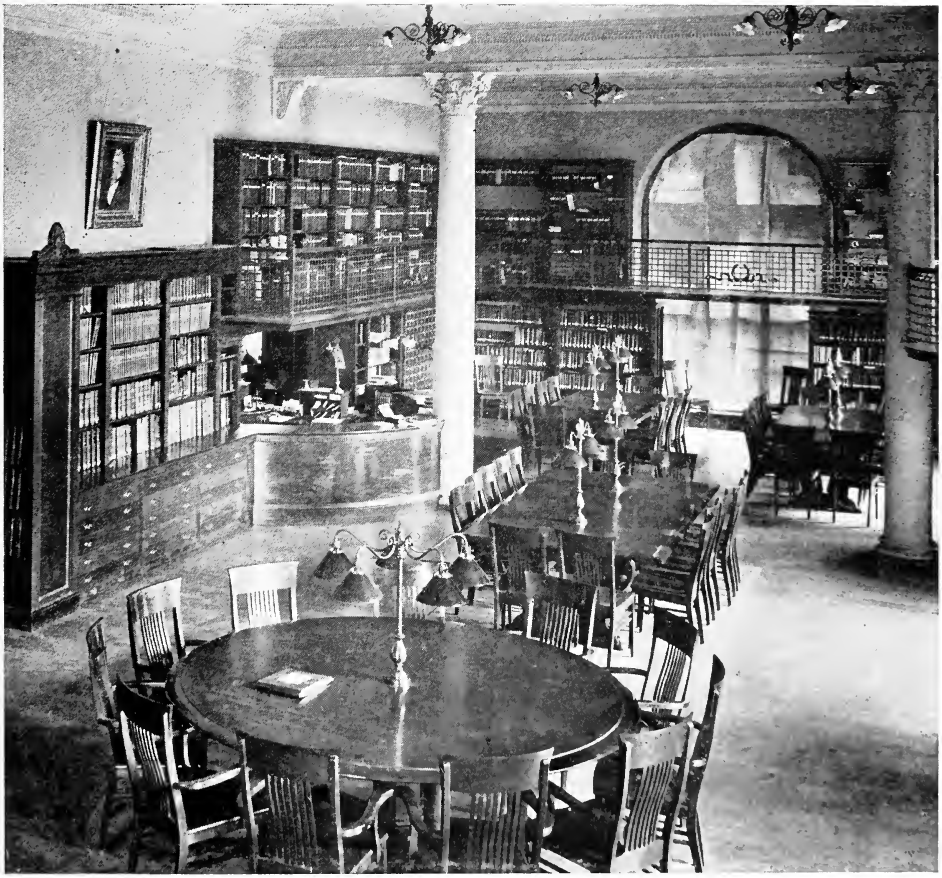
Thirty-six classes have graduated, numbering about twenty-nine hundred persons, a large proportion of whom occupy posts of responsibility in connection with the industries of the nation. In consequence, however, of the rapid growth of the school, more than half of these graduates belong in the last eight classes, and thus have not had sufficient time for gaining professional distinction.

On the list of graduates of the Institute is found a relatively small number of women. Much larger numbers have received instruction in partial courses. The number of women students at the Institute during the present school year (1903–1904) is twenty-six, some of them graduates of other colleges.

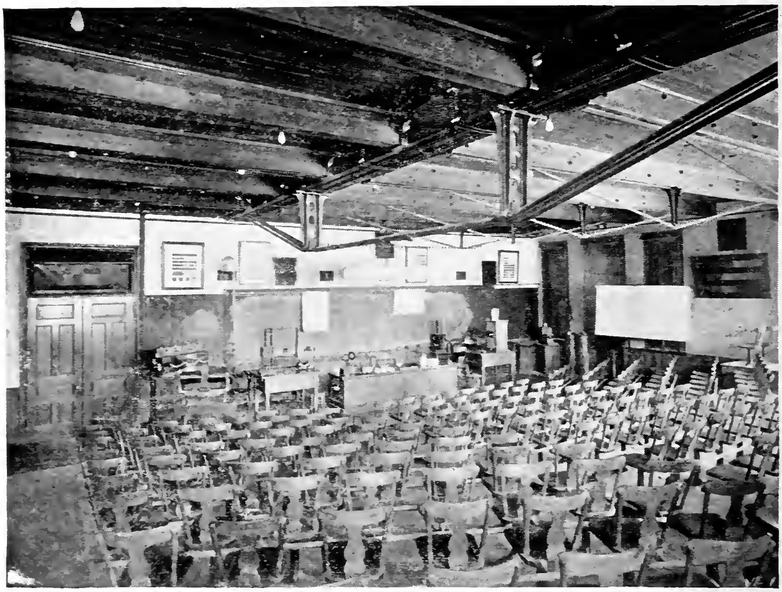
The departments which women most frequently enter are Chemistry, Physics, Biology, and Architecture. While in the lines indicated women students almost invariably do good work, it is not expected that their number here will greatly increase. The Institute of Technology is, by the nature of the case, essentially a man's college, though the Corporation and Faculty have seen no reason why any person who wishes to do the work of the school, and is qualified for it, should be excluded by reason of sex.

Admission.

THE requirements for admission are substantially the same as the requirements for graduation from a good high school or from the English or scientific department of an endowed academy. The examinations embrace Algebra, Plane and Solid Geometry, Physics, United States or Ancient History, French, German, and English Grammar and Composition. The average age of the entering class is a little over eighteen and a half years. Teachers are admitted to the Institute without examination. For those who can attend only in the afternoons and on Saturday forenoon, special provision and arrangements are made, to enable them, so far as possible, to take the courses for which they apply.



A CORNER OF THE GENERAL LIBRARY.



PHYSICAL LECTURE ROOM.

COURSES OF INSTRUCTION.

UNDERGRADUATE instruction at the Institute is given in thirteen four-year Courses, each leading to the degree of Bachelor of Science, and ranging from instruction in pure science, through the whole field of engineering subjects, to courses in architecture. The work of these Courses is, for the most part, prescribed, though a considerable specialization is possible as the student advances, by means of optional studies and thesis work. Choice of Course is made at the opening of the second term of the first year, when the differentiation in studies first takes place. With this slight respite, the student who is undecided at entrance has an opportunity to consult those who are better informed concerning the various Courses, and in some measure to ascertain his individual aptitudes for some of the fundamental subjects involved.

Civil and Sanitary Engineering.

The Course in Civil Engineering, established when the Institute was founded, is now one of the largest of the engineering departments. The Course covers topographical engineering; the building of railroads, harbors, docks, and other works serving the purposes of commerce and transportation; municipal engineering, including the construction of sewers, water-works, roads, and streets; structural engineering, including the construction of bridges, buildings, walls, foundations, and all fixed structures; and hydraulics, with a consideration of the development of water power and other problems. All of these branches rest, however, upon a relatively compact body of principles, and in these principles the students are trained by practice in the class-room, the drawing-room, the field, and the testing laboratory.

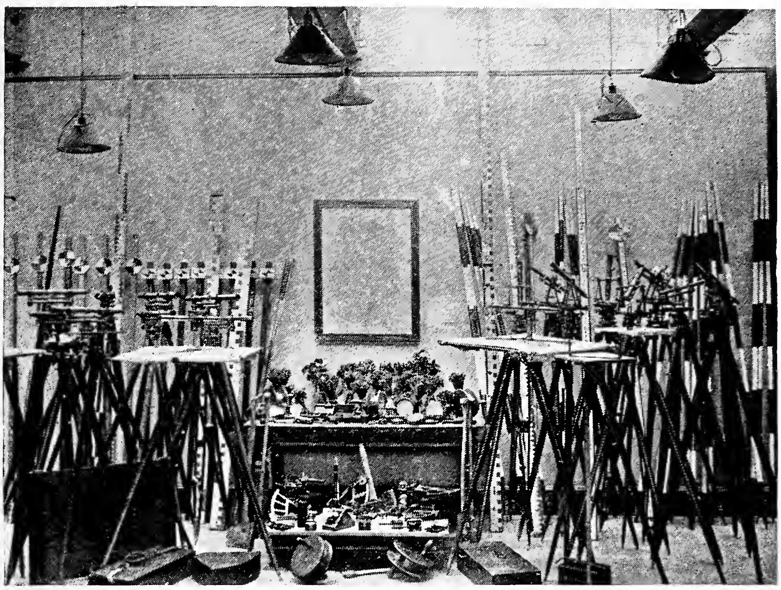
In view of the increasing importance of sanitary questions affecting the health of communities, a new branch of civil engineering was recognized by the Institute in 1889 by the establishment of a regular four-year Course in Sanitary Engineering. This Course is essentially one in civil engineering, but differs from the

regular instruction in that subject in that it omits certain general engineering subjects, and devotes the time thus gained principally to courses in chemistry and biology. In these it is designed to give the students such training as shall fit them to interpret properly the results of researches in sanitary chemistry and sanitary biology, and to co-operate with chemists and biologists in professional work. The Course devotes particular attention to the sanitary side of questions of water supply and drainage, and discusses, among other things, the principles of filtration and the methods of purifying water and sewage, the relation between drinking waters and disease, the methods of disposing of sewage, and other questions relating to the health of communities.

The Department of Mechanical Engineering, also one of the original departments, is now the largest in the school, having an instructing staff of nine professors and seventeen instructors and assistants. The Course aims to give the student a thorough training in the scientific principles that form the basis of all engineering, and to do this in such a manner that he may be able, instead of relying upon rule-of-thumb methods, to apply these principles to the solution of the practical problems that will arise after he leaves the school and enters active life. It aims not only to acquaint him with current engineering practice, but also so to develop the powers of his mind that he may be able, as occasions arise, to make improvements, and thus to keep abreast with the progress of the times. The students are required to perform tests in the engineering laboratories, and sufficient care is exercised in supervising their work to secure accuracy in the results of both the experimental observations and the computations. Moreover, the tests are performed under the conditions of practice; and the apparatus and machinery employed are of practical proportions.

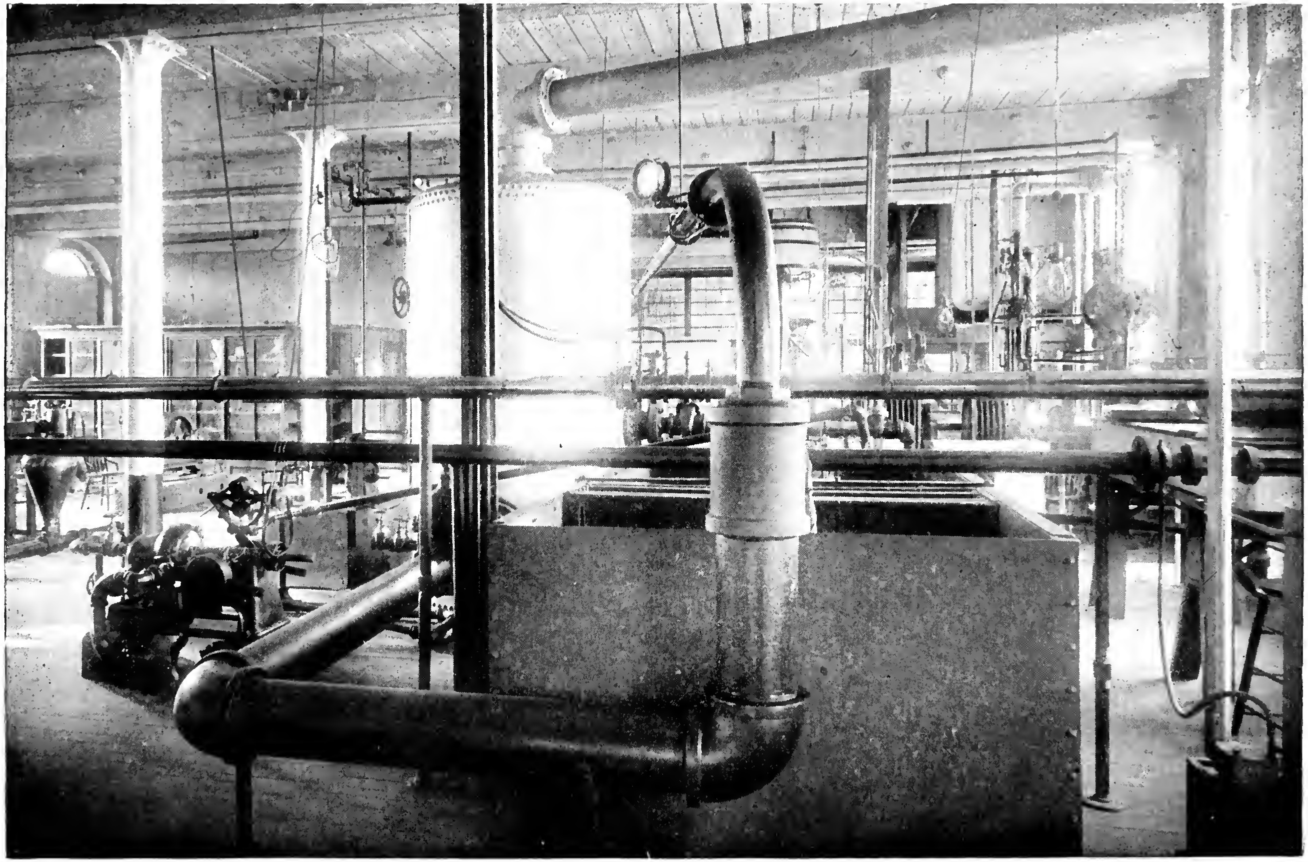
Mechanical Engineering.

In the work of the fourth year the option is given of courses in locomotive construction, marine engineering, mill engineering, and heating and ventilation. The course in locomotive engineering begins with a careful study of the details of the more usual types of locomotives, and of the strength of the more important parts.



SURVEYING INSTRUMENTS; CIVIL ENGINEERING DEPARTMENT.

HYDRAULIC FIELD WORK: LOWELL. USE OF CURRENT METERS.



PORTION OF HYDRAULIC LABORATORY.

The course in marine engineering includes a detailed study of the design and construction of single, compound, and multiple-expansion marine engines, with a discussion of their form, proportions, and efficiency, as well as of the strength of the several parts. Mill construction, together with the processes to be carried out in a cotton mill, is studied so far as to enable the student to take up intelligently the laying-out of machinery to best advantage, including the planning of the power plant and the distribution of power, all leading up to the designing of the complete mill building. The course in heating and ventilation is planned to acquaint the student with the fundamental principles of the subject, and as much of their practical application as is consistent with the primal aim of the course.

Mining Engineering and Metallurgy.

The mining and metallurgical laboratory was put into operation in the year 1871. Though previous to that time there were assaying laboratories in various schools, both in America and abroad, the Institute laboratories were the first in the world which were designed for the treatment of ores in economic quantities of from five hundred pounds to three tons, and used entirely for purposes of instruction. The opening of new fields for the mining and metallurgical engineer has recently caused the Course to expand, from nine graduates in 1899 to twenty-seven in 1903. The policy of the department is to give the pupil the underlying principles of mathematics, physics, chemistry, mineralogy, geology, mining engineering, and metallurgy, as well as some practical knowledge of mechanical, civil, and electrical engineering. Thus equipped, he can after graduation take up specialized work, with the expectation of carrying it on successfully. Two options are offered, with a differentiation of work extending through the last three years of the Course. The first is a general course, adapted to the needs of students who prefer not to make an immediate choice between professional specialties: the second group of optional studies is arranged with reference to mechanism and the steam-engine, and is adapted especially for the iron and steel metallurgist.

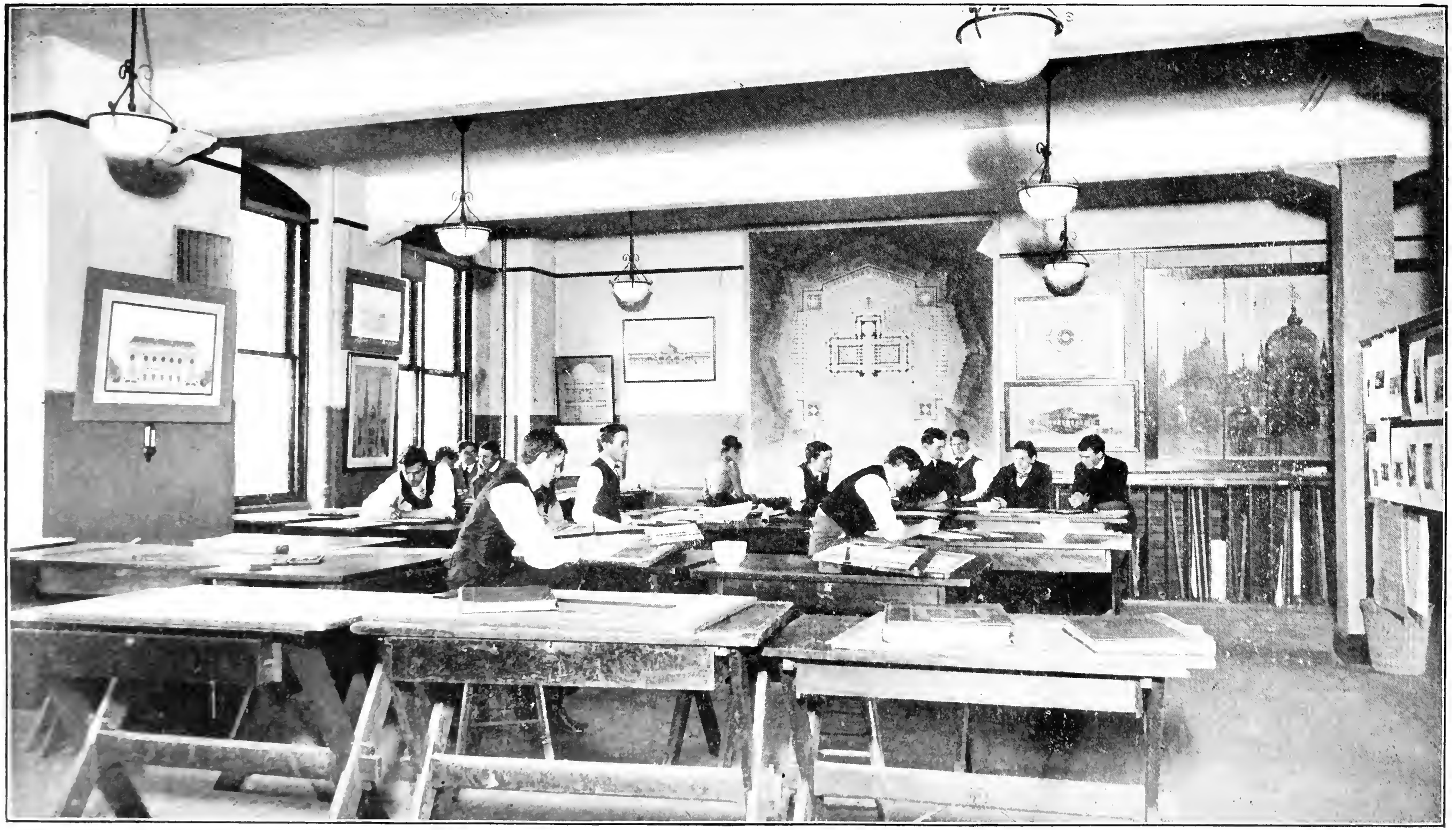
When the Course in Architecture was established, in 1866, there was no American precedent to aid in planning the scheme of instruction. The work of the department was planned, and has since been conducted, on a basis of the method pursued at the École des Beaux-Arts at Paris. The Course aims to give its graduates the ability to achieve grace and elegance in the expression of architectural ideas through an unerring and satisfactory adjustment of the structural parts. To extended courses in the history of art and architecture, and instruction in drawing, modelling, water-color, and pen-and-ink, is added a study of construction, including applied mechanics, graphical statics, and strength of materials, and also of materials, building stones, and working-drawings and specifications. For three years the students are continually engaged upon architectural design, and their work is examined and criticised before the class by a jury from the Boston Society of Architects.

Architecture.

The work of the architect, aside from the æsthetic design of his building, requires a good knowledge of engineering construction. To meet the problems which may present themselves in ordinary practice, a sufficient training is given in the general option. Those, however, who desire a more liberal allowance of engineering studies have also the opportunity of taking an option in architectural engineering, in which they are given a course in the theory and design of structures as rigorous as that received by students in civil engineering.

During the year 1899–1900 the Faculty established an option devoted particularly to landscape architecture, including, besides a large amount of work in architecture proper, instruction in horticulture and landscape design, on the one hand, and in surveying, topographical drawing, drainage, etc., on the other hand. The neighborhood of the Arnold Arboretum, where students in this option receive a part of their instruction, and the co-operation of the Department of Civil Engineering, make the Institute a peculiarly favorable field for such studies.

The Course in Chemistry is intended to furnish a thorough fundamental training in the science, and also to afford opportunity for



FOURTH-YEAR ARCHITECTURAL DRAWING ROOM.

specialization, when this is desired. A sufficient latitude in the selection of studies is allowed to provide both for students who intend to enter technical fields and for those who desire to fit themselves to enter positions as teachers or investigators. With this purpose in view, five series of optional studies have been arranged, running through the last three years of the Course. The first of these, with a relatively large amount of instruction in mechanical engineering and drawing, is recommended for those who look forward to positions in chemical manufacturing establishments where they will be called upon to superintend the running of machinery, and to take charge of various mechanical operations. The second comprises the laboratory courses on all the special branches of technical analysis,— namely, those on water, air, and food analysis, and proximate analysis,— and is of especial value to those who desire to fit themselves for the general practice of analytical chemistry, and for positions in such laboratories as those of railroads or manufacturing establishments. The third option gives a training in problems relating to the purification of water and sewage, the examination of food supplies, and industries in which bacterial action plays an important part. It is particularly designed to equip the student for the management of municipal laboratories. The fourth deals with assaying and metallurgical processes, including laboratory practice, and affords a preparation for management of blast-furnaces, smelters, etc. The fifth, with additional mathematics and pure physics, is intended as a training for teachers.

Chemistry and Chemical Engineering.

The Course in Chemical Engineering is adapted to meet the needs of students who wish to obtain such a knowledge of mechanical engineering and chemistry as will enable them to deal successfully with the application of chemistry to the arts, especially to those engineering problems which relate to the use and manufacture of chemical products. A greater proportion of the time is devoted to mechanical engineering subjects than is given to chemical subjects, and the training is more largely that of the mechanical engineer than of the chemist. A liking for mathematics and draw-

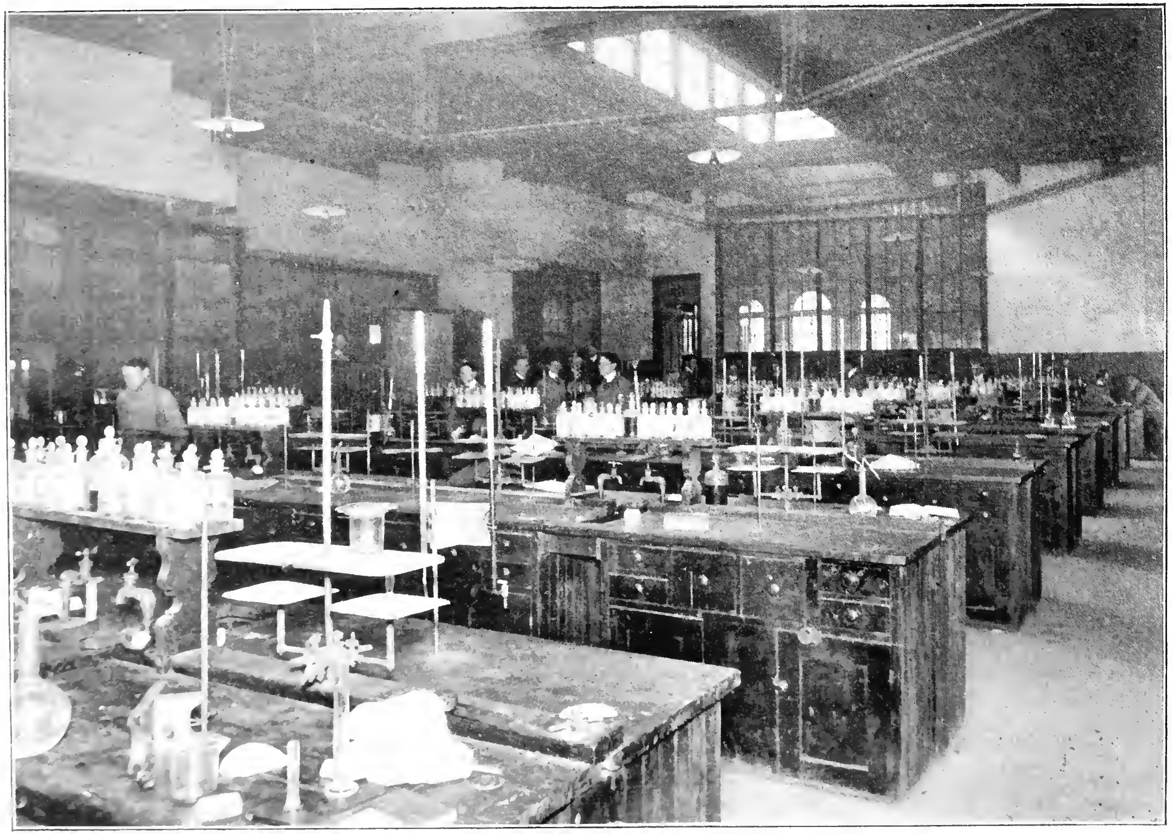
ing, and facility in these branches, are therefore essential qualifications for students who select this Course.

Fourth-year instruction in chemical engineering has been so arranged that the student can exercise a certain choice as to the topics to which he will devote special attention. He may receive instruction in textile coloring, in case he expects to find employment in the textile industries; in heat measurements, to fit him especially for operations involving the use of furnaces; in organic chemistry, if he intends to engage in the manufacture of dyes or other organic products; or in machine design, or hydraulics, if he desires to extend his engineering training. Graduates of this course find employment as engineers having to deal with problems of construction and administration in dye works and bleacheries, oil refineries, gas works, sugar refineries, soap works, paper and pulp mills, fertilizer works, chemical works, and various other branches of industry.

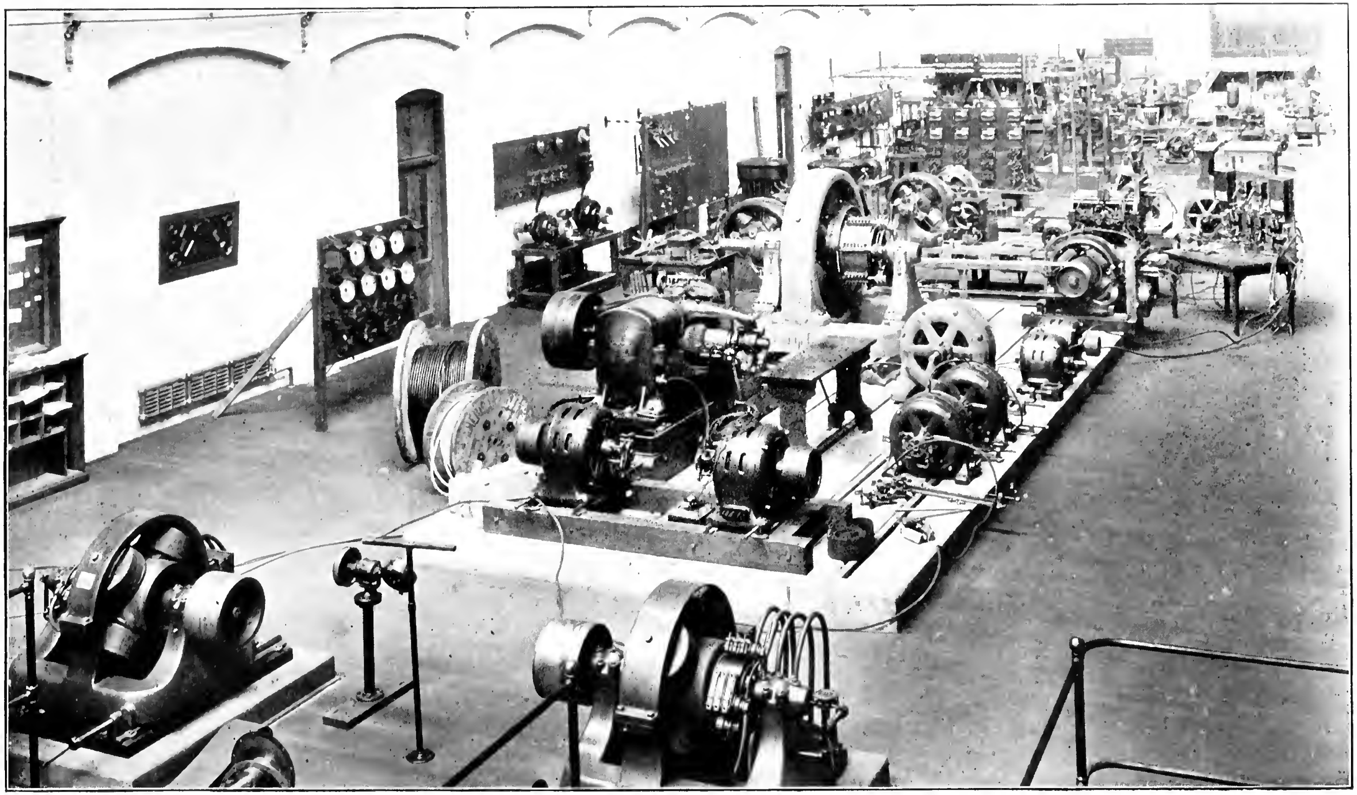
In 1882, in view of the increasing importance of electrical science, the Corporation established a Course in Electrical Engineering, setting an example which has since been followed by almost every large technical school, and founding a Course which is now one of the largest in the school.

Electrical Engineering.

Recent generous gifts to the Institute have made possible the erection of the new Lowell Laboratories of Electrical Engineering. These laboratories cover about 45,000 square feet, and, with their unusually complete equipment, offer facilities for instruction and research which are unsurpassed in this country or abroad. The Course in Electrical Engineering is intended to meet the demands of those who desire to enter upon the practice of any of the various applications of electricity in the arts, as, for example, telegraph and telephone engineering, electric lighting, electric railway work, and the electrical generation and utilization of power. Such work requires a knowledge of structures and machinery; and, accordingly, the Course embodies instruction in the principles of mechanism, mechanics, the strength of materials, thermodynamics, and steam engineering. At the same time a considerable training in pure mathematics and in the theory



LABORATORY OF ANALYTICAL CHEMISTRY.



LABORATORY OF DYNAMO-ELECTRIC MACHINERY, LOOKING SOUTH.

of electricity is required. As the Course advances, a greater proportion of time is given to technical electrical studies, including such subjects as dynamo-electric machinery, periodic currents, electrical measurements and testing, and the various technical applications of electricity.

Biology.

The Course in Biology is designed for students who want a thorough training in the principles of the subject, and desire eventually to become biologists, bacteriologists, investigators, or teachers; to engage practically in one of the various fermentation industries, or in the public health service; or to enter those higher medical schools which now require, besides the regular bachelor's degree, special preparation in biology, physics, chemistry and modern languages. In all of these lines, but especially perhaps in bacteriology, the sanitary or public health sciences, and the higher preparation for medical studies, useful and inviting careers are open to earnest and capable students.

The Course includes a generous allowance of chemistry, physics, and modern languages, as well as so much of mechanical and free-hand drawing as is required of most first-year students, and the same amount of English literature, history, and political economy prescribed for the engineering Courses. More geological instruction is provided than in other Courses, excepting those in Geology and Mining, so that the training afforded by the Course in Biology is especially broad and liberal. Abundant facilities for the practical work are furnished in the various laboratories of the Institute, especially those of chemistry, physics, physiology, and bacteriology.

Physics.

A Department of Physics was part of the original plan of President Rogers, and was created soon after the founding of the Institute. It has since grown to be one of the best equipped departments of the Institute, with a teaching force of sixteen.

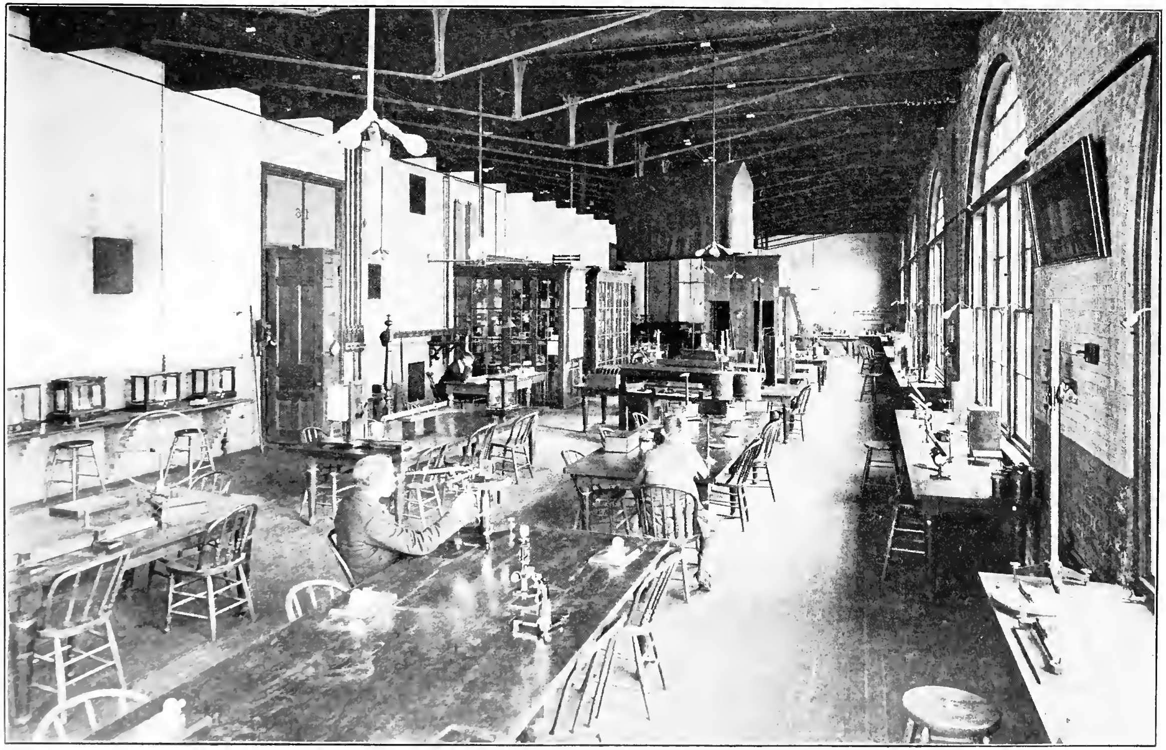
The Course in Physics is of a distinctly scientific nature. It contains a series of studies adapted to the needs of those who wish to become teachers of physics, or who desire to enter upon a course in pure science, whether with a view to its further continuance or wholly as a matter of training. Its leading features are a thorough

and continuous study of the various branches of physics, and a treatment of mathematics advanced considerably beyond the requirements of any of the technical Courses. General, theoretical, analytical, and organic chemistry occupy a position next in prominence to mathematics, and of hardly less importance. Options are so arranged that the student may select more advanced work in either mathematics or chemistry.

To meet the wants of students desiring to prepare for entrance into the various electro-chemical or electro-metallurgical industries, the Institute has established a course of study leading particularly to this end, and planned as an option in the Course in Physics. Its main features are a very thorough training in electrical and chemical subjects, which extend throughout the whole Course, and the distinctly professional work in electro-chemistry, which runs through the fourth year. The electrical studies include courses in theoretical electricity, periodic currents, and the theory of alternating current machinery, an extended laboratory course in electrical measurements and testing, and a course in direct and alternating current generators and motors and power transmission, with practice in the laboratory of electrical engineering. The instruction in chemistry is devoted chiefly to courses in analytical, theoretical, and industrial chemistry. The work in electro-chemistry extends throughout the fourth year. During the first term the theory of the subject is taken up in a course of lectures which are accompanied by extended laboratory practice in electro-chemical measurements. The results obtained in the laboratory are discussed in a series of conferences. In the second term the instruction is continued by courses of lectures on applied electro-chemistry, including electro-deposition, accumulators, electric furnaces and their products, electrolytic processes, and electro-metallurgy, and by work in the laboratory of applied electro-chemistry.

General Science.

For students who wish a general training in pure science with a view to teaching or research, the Institute has for some time made provision, particularly in the Courses in Physics and Chemistry. In addition to these, it has recently been decided to establish a Course in General Science,



GENERAL PHYSICAL LABORATORY.

DRAWING ROOM OF THE DEPARTMENT OF NAVAL ARCHITECTURE.

intended chiefly as a preparation for teachers. The Course will embody the general scientific studies required in all Institute Courses, but beyond that is intended to afford considerable liberty of choice as to the selection of the branches of science to be pursued.

Geology.

The Course in Geology affords a general education in natural science, with special training in geology. The occupations which its students may naturally have in view include employment in responsible positions upon local, state, or national surveys, practice as professional geologists in any of the economic or technical relations of the science, or in connection with collegiate or other institutions. The demand for men who have united topographic with physiographic and geologic studies has been increased by the modern methods of conducting governmental and other surveys. That the students may be better prepared for such work, the amount of topographic, geodetic, and hydrographic surveying is larger than has been common in geological courses.

Naval Architecture.

The Course in Naval Architecture was established in 1893, after a preliminary experience of four years with an option for students of engineering. This Course provides a thorough training in the theory and methods of designing and building ships, together with a study of the properties requisite for safety and steadiness at sea. It aims to furnish a well-rounded preparation, appropriate for those who expect to enter the regular work of the profession as ship-builders, ship-designers, ship-managers, or marine engine builders. So great has been the demand in recent years for training in naval architecture that the Course now numbers in all eighty-five graduates.

The Institute has been selected by the United States Naval Department to give professional instruction to officers designated for the corps of naval constructors. A special course covering four years is given, including, in addition to the general training and the professional work of the regular four-year Course, thorough instruction in the theory and practice of war-ship design. Much attention is given to electrical engineering, and especially to the applications of electricity on war-ships.

In connection with all these Courses a high grade of thesis work

is maintained in the fourth year. Many of the theses prepared by the students as a condition of graduation have been published in the Proceedings of the Institutes of Mining Engineers, of Civil Engineers, of Mechanical Engineers, in the *Chemical Journal*, in the Proceedings of the American Academy of Arts and Sciences, or in other connections. It is intended that all the thesis work done shall attain the character of original investigation or design, and shall show in the cases of successful candidates for the degree the capability to initiate and conduct, upon strictly scientific principles and by approved methods, tests, experiments, or constructive work. Whenever the nature of the investigation, research, or design, is such as to render collaboration necessary or useful, two students are allowed to work together upon a thesis.

Theses.

Graduate Courses, with or without reference to the advanced degrees of Master of Science, Doctor of Philosophy, and Doctor of Engineering, may be pursued by students who satisfy the Faculty of their preparation for such work. Schedules of such Courses have been arranged in several departments, and are published in the Catalogue; but they are intended only as typical, and do not limit in any degree the wide range of subjects from which such students may elect the courses they wish to pursue. More and more attention is being paid, also, to research work. Within the last three years there have been established, as distinct departments of the Institute, the Graduate School of Engineering Research, the Research Laboratory of Physical Chemistry, and the Sanitary Research Laboratory and Sewage Experiment Station. These will be found fully described in special pamphlets. The work of these departments, aside from its value in adding to scientific knowledge, is likely, in fostering the spirit and ideals of research, to be of far-reaching consequence in connection with all the work of the school.

Graduate Courses.

The degree of Bachelor of Science (S.B.) is given for the successful completion of any one of the four-year courses. The degrees of Master of Science and Doctor of Philosophy are offered for the completion of advanced courses of study; and that of Doctor of Engineering for the satisfactory accomplishment

of a course of original investigation in the School of Engineering Research.

Summer schools are maintained by the Institute in the departments of Civil Engineering, Mining Engineering, and Architecture.

Summer Schools.

That in civil engineering affords continuous field practice in geodesy and hydraulics during about a month. That in mining engineering affords students an opportunity to visit mining or metallurgical works, and to become practically acquainted with the methods employed by actually taking part in them. These summer schools in mining and metallurgy have been held in all parts of the country, from Nova Scotia to Lake Superior and Colorado. The summer school in architecture consists not infrequently of a trip abroad, with detailed studies and sketches of special types of architecture.

In addition to the professional summer schools, summer courses are held at the Institute during June and July. These courses are

Summer Courses.

valuable for graduates of colleges who desire to enter the Institute with advanced standing, and who for that purpose may have occasion to make up some of the work of the earlier years. The courses thus far held at the Institute during June and July have included instruction in mathematics, chemistry, physics, modern languages, drawing, descriptive geometry, civil engineering, mechanical engineering, applied mechanics, and mechanic arts. A circular giving details in regard to these courses will be mailed, on application, about April 1.

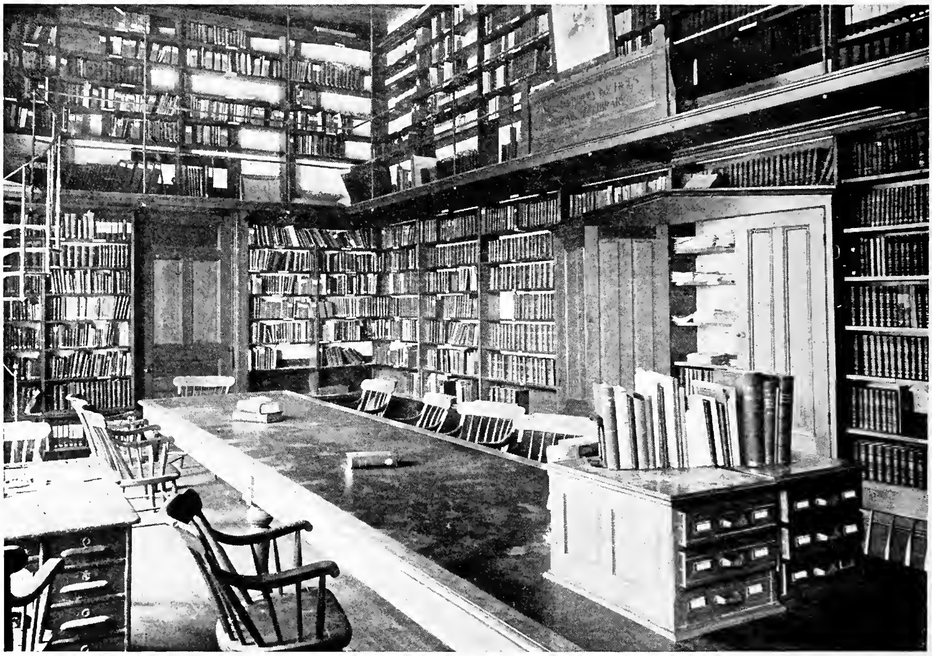
BUILDINGS.

THE buildings occupied by the Institute are eight in number. The two buildings first constructed, known respectively as the Rogers and the Walker Buildings, are situated upon Boylston Street, one of the great thoroughfares of Boston, upon land ceded by the Commonwealth of Massachusetts. The Rogers Building comprises a hall capable of seating nine hundred persons, used for public gatherings and commencement exercises, and for the lectures of the Lowell Institute, numerous lecture-rooms, recitation-rooms, and drawing-rooms, the general library, and the administrative offices. The Walker Building, on the same square, built in 1883, is occupied by the Departments of Chemistry and Physics. In addition to the Rogers and the Walker Buildings, four others, three of which adjoin and now form one structure, are situated on Trinity Place. The Henry L. Pierce Building, the newest of these, is of fireproof construction, with steel doors, so arranged that fire can be easily controlled. Especial attention has been paid to the heating and ventilation, and an abundance of properly tempered fresh air is delivered to all parts of the building. The glass in the windows in laboratories on the southerly exposure is ribbed to diffuse the light. The Lowell Laboratories of Electrical Engineering, on Clarendon Street, afford accommodation for the exceptionally complete equipment in electrical engineering, and for the Department of Modern Languages. Indirect heating is applied to all the buildings erected since the Rogers Building.

In addition to these, the Institute has, at the foot of Garrison Street, a series of mechanical laboratories, which, with the boiler house and chimney, cover about 24,000 square feet on the ground.

Plans are now in preparation for an additional building to be constructed in the near future. It will be a memorial of the late President Walker, and will be devoted to the social and physical interests of students. It will include a large gymnasium, a recep-

AN ALCOVE IN THE ARCHITECTURAL LIBRARY.



NICHOLS LIBRARY, DEPARTMENT OF CHEMISTRY.

tion-room, a library, and numerous small rooms for special purposes. Toward the erection of this building the alumni of the Institute have subscribed more than a hundred thousand dollars.

LIBRARIES.

FOR greater convenience of reference, most of the books owned by the Institute are arranged in departmental libraries. There are in all eleven of these, with an aggregate number of over sixty-four thousand volumes. The most valuable of the Institute libraries is the William Ripley Nichols Chemical Library, numbering more than 9,000 volumes and 1,700 pamphlets. The Engineering Library comprises 11,000 volumes; the Physical Library, 7,000; and the Library of Political Science, 11,000 volumes. The Architectural Library comprises 3,000 volumes, chiefly illustrated works, and 11,000 photographs. The General Library, on the first floor of the Rogers Building, contains a large number of reference works, complete sets of the publications of the Institute and of its officers, the library of the Department of English, and a general card catalogue, showing where every book in any collection is to be found.

The several libraries are so arranged and conducted that a student can consult them with the smallest possible loss of time. The students have free access to the card catalogues and to the shelves. Each library is also used as a reading-room, all the magazines and journals belonging to the department being freely accessible. The number of periodicals received at the Institute is over nine hundred, forming one of the largest collections of scientific journals, magazines, and reviews to be found anywhere.

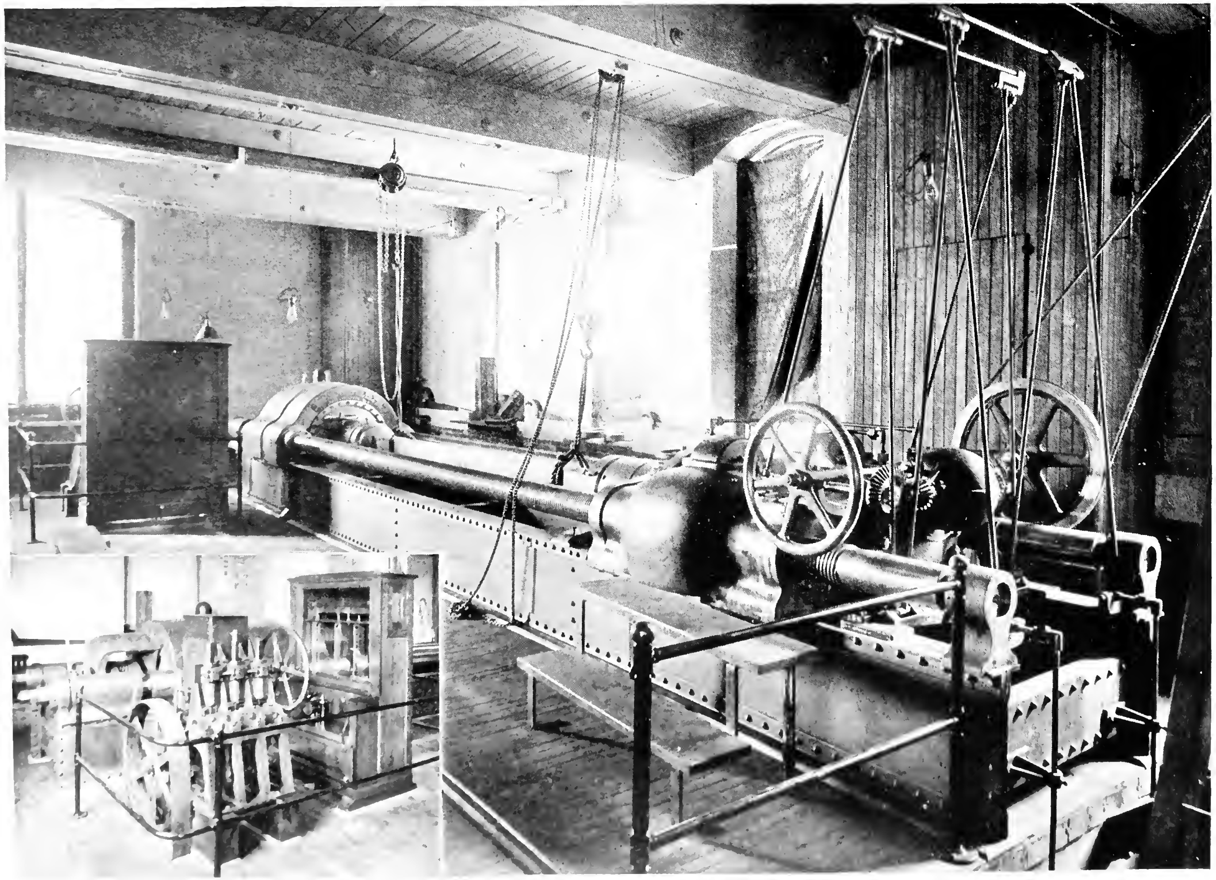
LABORATORIES.

A MARKED characteristic of the Institute is the large amount of laboratory work embodied in its Courses. Systematic experimentation is insisted upon at nearly every point in every Course, to illustrate, to enforce, and to supplement the work of the recitation-room, the lecture-room, and the drawing-room, and also to implant in the student a proper conception of the nature and methods of investigation.

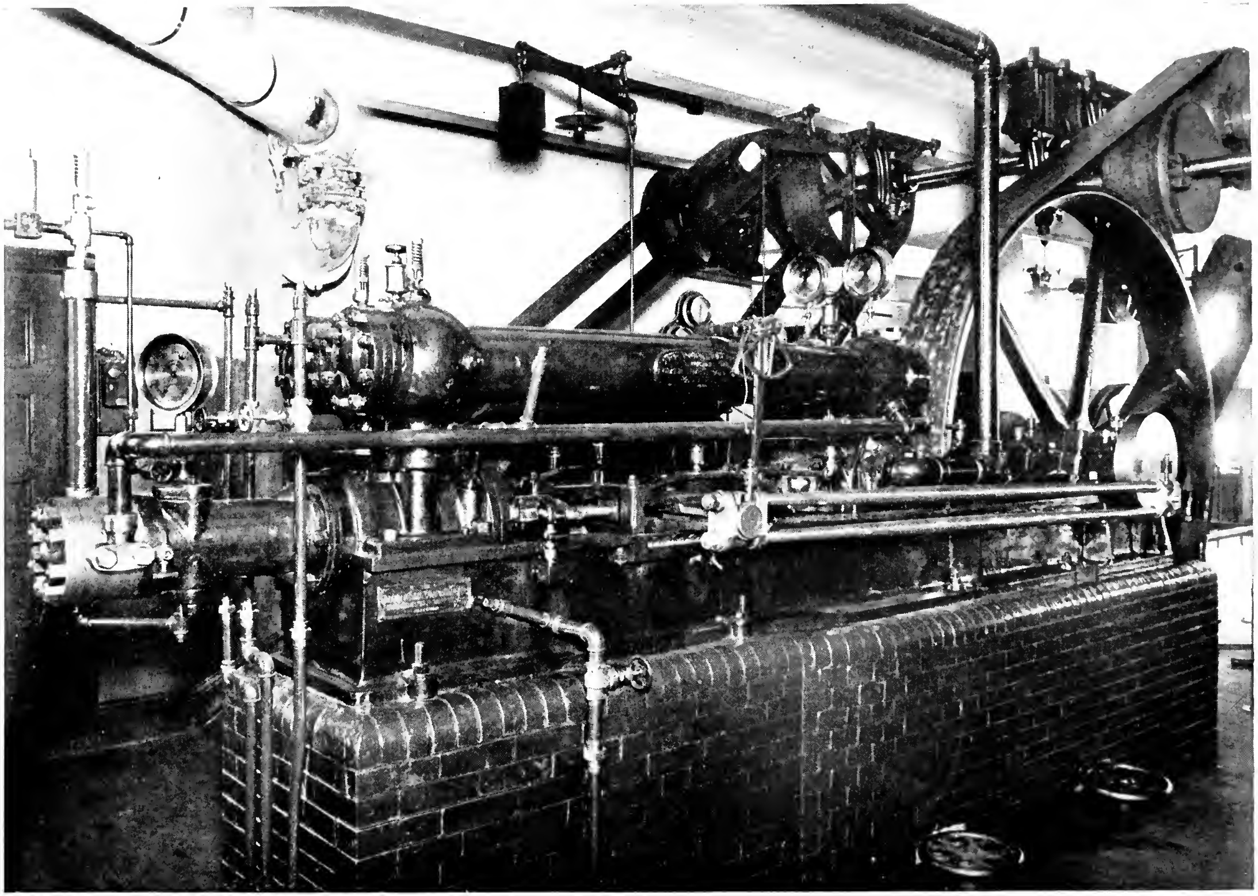
Without attempting a detailed discussion of precise points of priority, it may be fairly affirmed that the Institute has led in the development of laboratory instruction in physics and chemistry to students in large classes; in the organization and equipment of mining and metallurgical laboratories for instruction by treatment of ores in large quantities; in the establishment of a laboratory for teaching to large classes the uses and properties of steam; in the establishment of a laboratory for the comprehensive testing of strength of materials in commercial sizes by students; and in the recognition of the importance for engineering courses of instruction in mechanic arts.

The buildings of the Institute, in addition to all drawing, recitation, and lecture rooms, and libraries, comprise several laboratories or groups of laboratories. These are: the Engineering Laboratories; the John Cummings Laboratory of Mining Engineering and Metallurgy; the Kidder Chemical Laboratories; the Research Laboratory of Physical Chemistry; the Augustus Lowell Laboratories of Electrical Engineering; the Biological Laboratories; the Sanitary Research Laboratory and Sewage Experiment Station; the Rogers Laboratory of Physics; the Geological and Mineralogical Laboratories; the Mechanical Laboratories; and the Geodetic Observatory.

The Engineering Laboratories are the logical outcome of the policy pursued by Professor Rogers, the founder of the Institute, of supplementing class-room instruction with laboratory work, so as to make the student realize what he is studying, and to give him a



TESTING MACHINE (EMERY PATENTS). CAPACITY, 300,000 POUNDS.



THREE-STAGE AIR COMPRESSOR.

proper conception of the nature and method of investigation. Their very extensive equipment has been chosen so as to supplement the instruction in the class-room with experiments upon a practical scale, and to give the student practice in such experimental work as engineers, in the pursuit of their profession, are called upon to perform. The laboratories also provide facilities, in connection either with the daily exercises or with theses, for considerable original investigation, and the result has been the publication of a large amount of valuable engineering data.

Engineering Laboratories.

Students who are admitted into these laboratories have already had class-room instruction in hydraulics, steam, applied mechanics, mechanism, and valve-gears. They are thus able to begin the tests with little assistance from the instructor, so that practically the whole of the laboratory period is available for actual work.

The aim of the instruction is to make them familiar with all the different classes of testing, and also with the different methods of measurement used in each class. In the work on pumps, for example, the student is given practice in the measurement of water by direct weighing, by displacement, by the use of weirs both with and without contractions, by triangular notches, by hose nozzles, by orifices in a thin plate, and by mouth pieces. Having used all these methods the student learns the degree of accuracy of each, and becomes competent to judge which is best suited for any similar work he may have to do. The different methods of measuring steam, heat, and power, are brought to his attention in the same way.

Classes of about thirty men work in the laboratory at one time for a period of about two hours. Ten or more different tests are carried on simultaneously. The number of observers assigned to any test is determined by the number of simultaneous observations required, and is kept as small as is consistent with obtaining accurate readings. At the end of a test all observations are copied by the student on a printed log-sheet, which is kept by the instructor. Each student copies on a small, printed log-sheet a summary of the observations recorded on the large log. After leaving the laboratory, the student computes the results for the test upon which he has

worked, and later hands in his computations and results to be examined and corrected by the instructor.

A detailed account of the equipment of the Engineering Laboratories is given in the annual Catalogue. They occupy a floor area of about 23,500 square feet, and embrace the Applied Mechanics Laboratory, the Hydraulic Laboratory, and the Steam Laboratory.

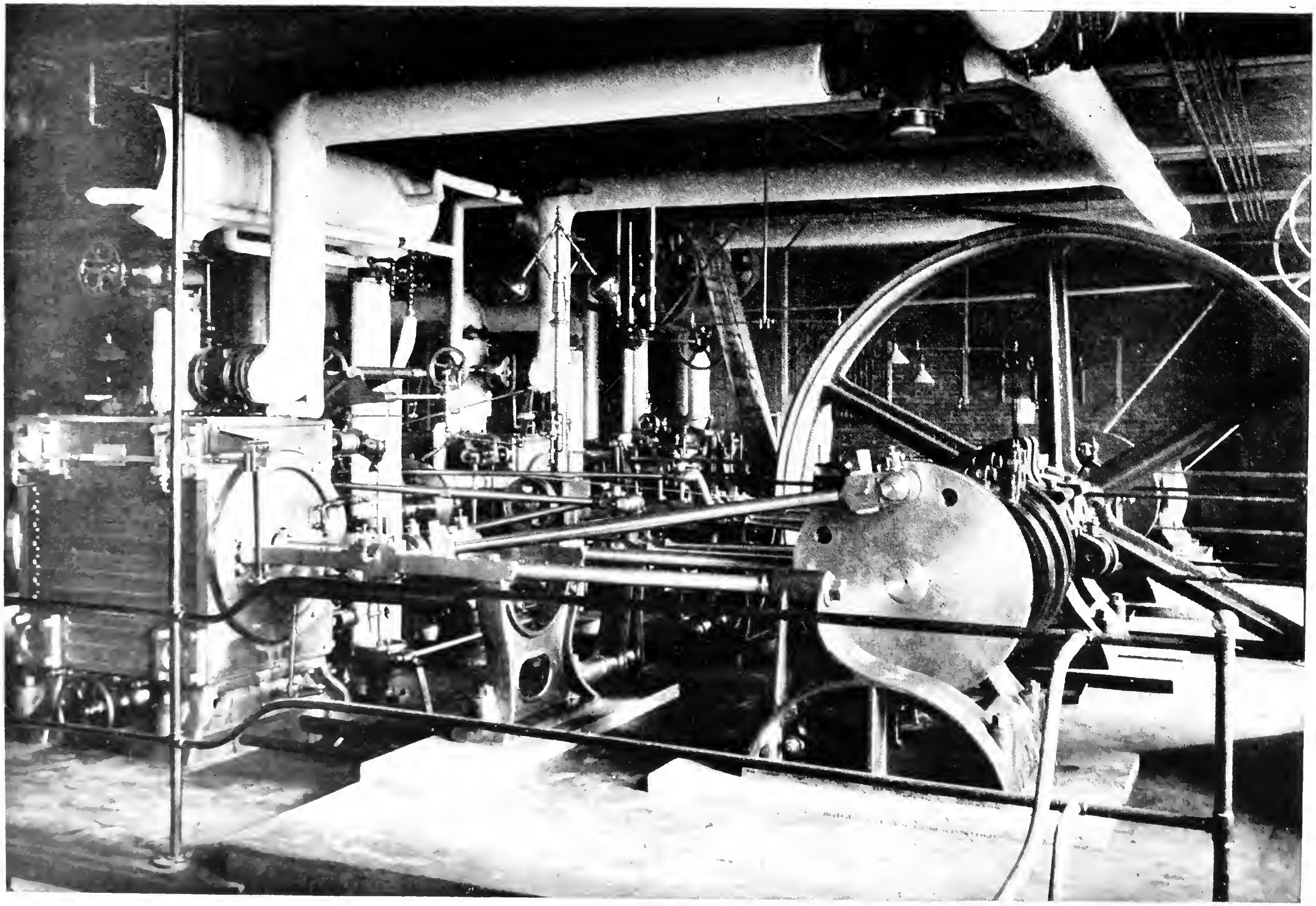
Among the larger pieces of apparatus in the Applied Mechanics Laboratory may be mentioned the following: an Emery testing machine of 300,000 pounds capacity for tension or compression. This machine takes a tension specimen up to twelve feet in length, and a compression specimen up to eighteen feet in length. A transverse testing machine of 100,000 pounds capacity for testing I-beams, girders, timber beams, floor systems, etc., up to twenty-six feet span; a torsion testing machine of 150,000 pounds capacity. This machine has sufficient power to twist off a three-inch diameter mild steel shaft, and takes specimens under eighteen feet in length.

In the Steam Laboratory, a triple expansion Corliss engine, with cylinders, nine, sixteen, and twenty-four by thirty inches; a 225-horse-power, tandem compound, McIntosh and Seymour engine; a thirty-five horse-power Otto gas-engine, provided with gasometer tanks for measuring the air supplied, meters for measuring the gas, and a calorimeter for measuring the exhaust waste; a pulsometer of 1,000 gallons capacity per minute; and a complete outfit for making liquid air.

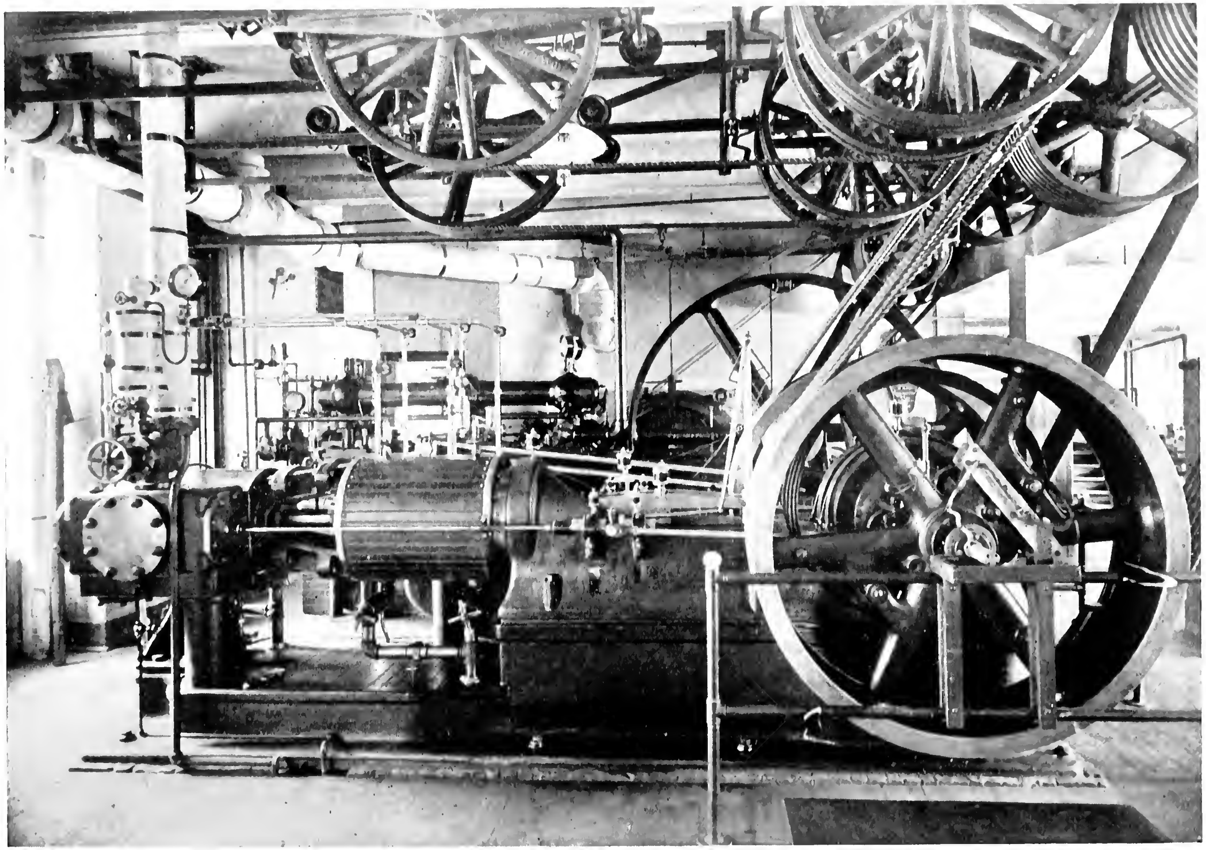
In the Hydraulic Laboratory, a thirty horse-power Pelton water wheel; a twenty horse-power American impulse wheel; a double Rife hydraulic ram with four-inch drive pipe eighty feet long; a stand pipe eighty feet in height; twenty-four and forty-eight inch weirs, etc.

Investigations are frequently made upon outside plants; for example, a forty-hour test on the Westinghouse unit (3,700 horse-power) at the Lincoln Wharf Station of the Boston Elevated Railway Co.; and a twenty-four hour duty trial on the Leavitt high duty pumping engine at Chestnut Hill.

The work in the Engineering Laboratories is an important part,



TRIPLE EXPANSION ENGINE, CORLISS TYPE.



TANDEM COMPOUND HIGH-SPEED ENGINE.

not only of the Course in Mechanical Engineering, but of those in Civil Engineering, Electrical Engineering, Chemical Engineering and Naval Architecture.

Reference may be made to the special circular of the department for plans of the laboratories and a detailed account of the equipment and of the tests made.

The Laboratories of Mining Engineering and Metallurgy.

The John Cummings Laboratories of Mining Engineering and Metallurgy comprise laboratories for the assaying, concentrating, milling, and smelting of ores, and for the heat treatment and microscopical examination of metals and alloys. The purpose of the laboratories is twofold,— to illustrate the lecture instruction, and to teach the student how to carry out mechanical and chemical working tests on ores, fuels, and furnace materials. The size of the apparatus is such as not to require too much material and time, or too much bodily exertion from the student, while at the same time results of real value are obtained. The machines are so arranged that they can be worked alone or in connection with others, and with variable speed, and the different parts of a machine are so put together that they can be readily taken apart and single parts interchanged, when the experiment requires such a modification.

The mechanical work is carried on with ore-dressing machinery, and the chemical work with metallurgical apparatus. In either class of work the student, having received a suitable amount of ore for treatment, and having ascertained by mineralogical, chemical, and other tests its composition and value, proceeds with the experiment, measuring, weighing, and assaying, and recording each step accurately in his report. The results are, as a rule, of practical value in the concentration of ores and in such metallurgical operations as roasting, amalgamating, leaching, electro-deposition, etc. Those in smelting are likely to compare unfavorably with large-scale work. Nevertheless, stress is laid on smelting in the laboratory for the reason that in no other way can a student learn the principles on which smelting operations are based, and how to control them by chemical analysis, so well as by doing it himself, even

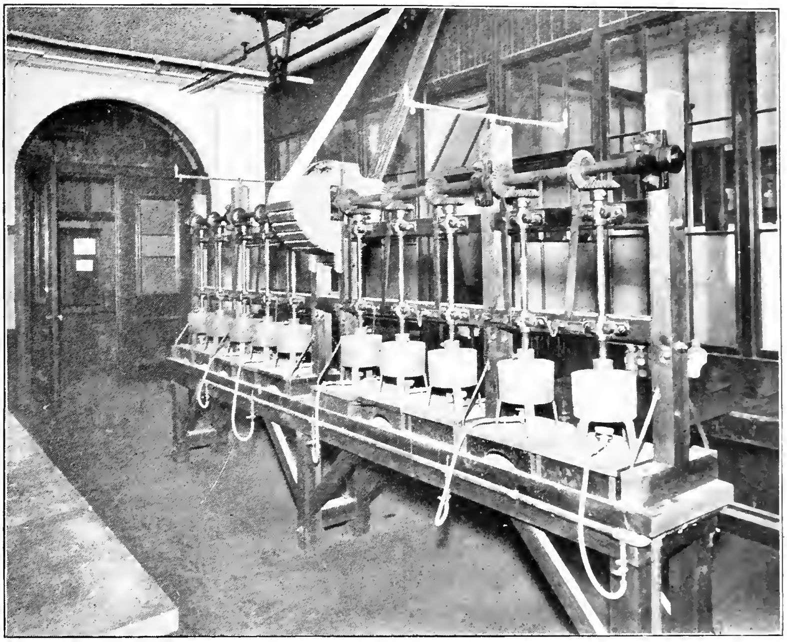
under conditions where time and money do not have to be taken into consideration. In the fourth year students take up metallographical studies.

Among the divisions of the laboratory are a dry assay laboratory, which contains a full equipment of balances, besides crucible and muffle furnaces for assaying lead, silver, gold, and other ores; a wet assay laboratory where leaching and amalgamating tests, on a small scale, are carried on; and a milling-room, which contains a variety of concentrating machines, several stationary leaching vats of different sizes, revolving barrels, and a complete plant for experimenting upon the electro-depositing and refining of metals in the wet way. In addition to these individual machines, in the milling-room are found the necessary apparatus for the crushing, grinding, and sampling of ores in general; a three-stamp mill, used principally for the milling of gold ores; a Frue vanner with plain and corrugated belt; an Embrey table, two Wilfley tables, and a Wilfley slimer; a circular slime table, a Collom and a Harz jig for concentrating different-sized ores; and, lastly, four steam drying-tables.

Besides these departments, the John Cummings Laboratory is provided with a smelting-room, containing several furnaces for roasting and smelting; a room for instruction in metallography, a subject the value of which for the mining engineer is being increasingly recognized in all large works; a library of over four thousand volumes and pamphlets; and a museum.

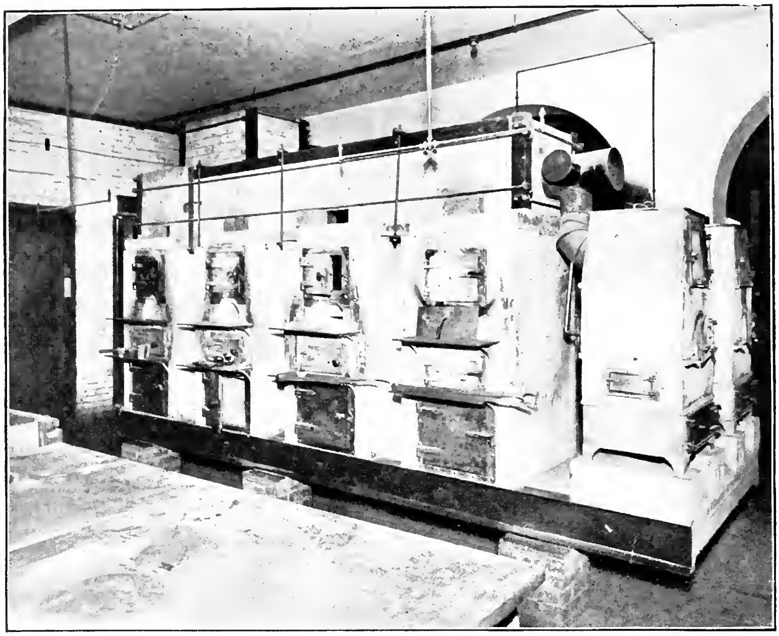
The Kidder Chemical Laboratories.

The chemical laboratories are among the largest and best equipped in the country, including about twenty laboratories for students, with places for nine hundred and fifty workers. The largest of these is devoted to the instruction in inorganic chemistry given during the first year to all students entering from secondary schools. This includes the preparation and study of the non-metallic elements, such as oxygen, hydrogen, chlorine, sulphur, etc., and the study of the principles underlying the system of qualitative chemical analysis, by means of which the constituents of common substances can be recognized.

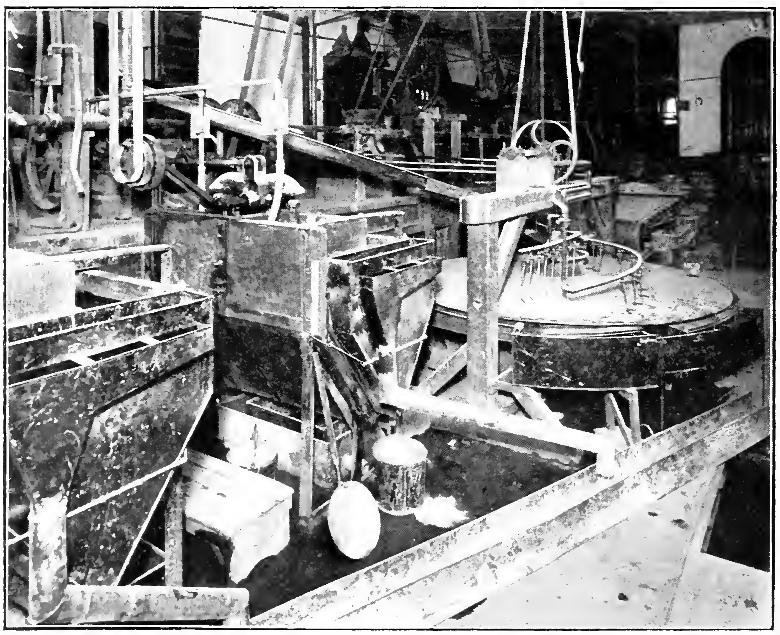


AMALGAMATING PANS.

STATIONARY LEACHING VATS.



MUFFLE-ASSAY FURNACES.



COLLOM JIGS AND CONVEX CONTINUOUS ROUND-TABLE.

The instruction in qualitative analysis is continued in other large laboratories of the Institute by students of the second year, and includes the examination of more complex bodies, such as alloys, irons and steels, glasses, minerals, ores, and many materials common in daily life. This, in turn, is followed by a study of the methods for the measurement of the various constituents of which these substances are composed; that is, a study of the methods of quantitative chemical analysis. Over two hundred working places are provided for these students and the laboratories are equipped with all appliances for rapid and accurate work, including an ample supply of balances, graduated apparatus, platinum ware, and devices for electrolytic work. The desk assigned to each student is available at all times during the working hours.

Smaller special laboratories are also provided as follows: A laboratory for water, air, and food analysis, provided with special forms of apparatus for this line of work, including the examination of potable waters and of boiler waters, of milk, butter, flour, preserves and condiments of all sorts; a laboratory devoted to the study of optical methods of analysis, with special reference to sugars and starches; a laboratory for the analysis of illuminating gas, and of flue and fuel gases, with all of the typical forms of apparatus peculiar to this branch of analytical chemistry; a laboratory for the examination of oils used as foodstuffs or as lubricants; and a laboratory devoted to the study of methods of proximate technical analysis, as applied to tanning materials, rubber, paper, etc.

Several laboratories are devoted to instruction in industrial chemistry. The main laboratory is provided with apparatus illustrative of the important general processes employed in manufacturing plants, such as modes of filtration, evaporation, and crystalization, or the grinding, crushing, lixiviating or drying of materials. The student is taught to use these pieces of apparatus in connection with the recovery of some waste-product, the production of some pure chemical, or the study of an industrial process, and is required to take into account as many elements affecting the cost and efficiency of operation as possible and to make a report based upon his conclusions. In connection with the industrial branch of the depart-

ment there is a laboratory devoted to the dyeing of textile fabrics in which the important typical processes of dyeing and mordanting are illustrated and carried out by the student.

The laboratory of organic chemistry is equipped for the preparation of typical organic compounds and also for the systematic study of the reactions by which the various classes of organic bodies, such as hydrocarbons, alcohols, ethers, aldehydes, acids, and the like, may be identified. It is liberally provided with combustion furnaces, bomb furnaces, and facilities for distillation with steam, in vacuo, etc.

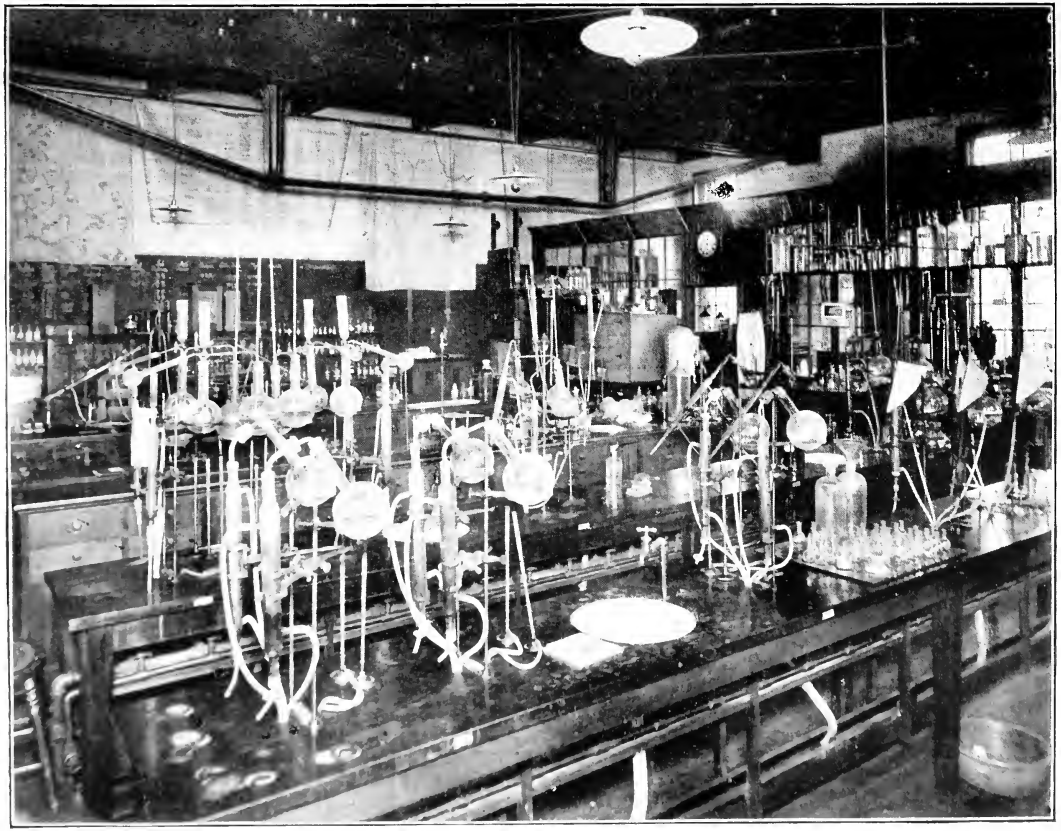
The instruction in theoretical and physical chemistry is also accompanied by laboratory practice for which special laboratories are provided, and these are equipped with sets of apparatus for the measurement of electrical conductivity, for the determination of molecular weights by standard methods, for the measurement of small and large changes in temperature, pressure, or electrical energy, etc.

Special opportunities are also provided for advanced students in any of the branches of the science named above and for students engaged in research as candidates for advanced degrees.

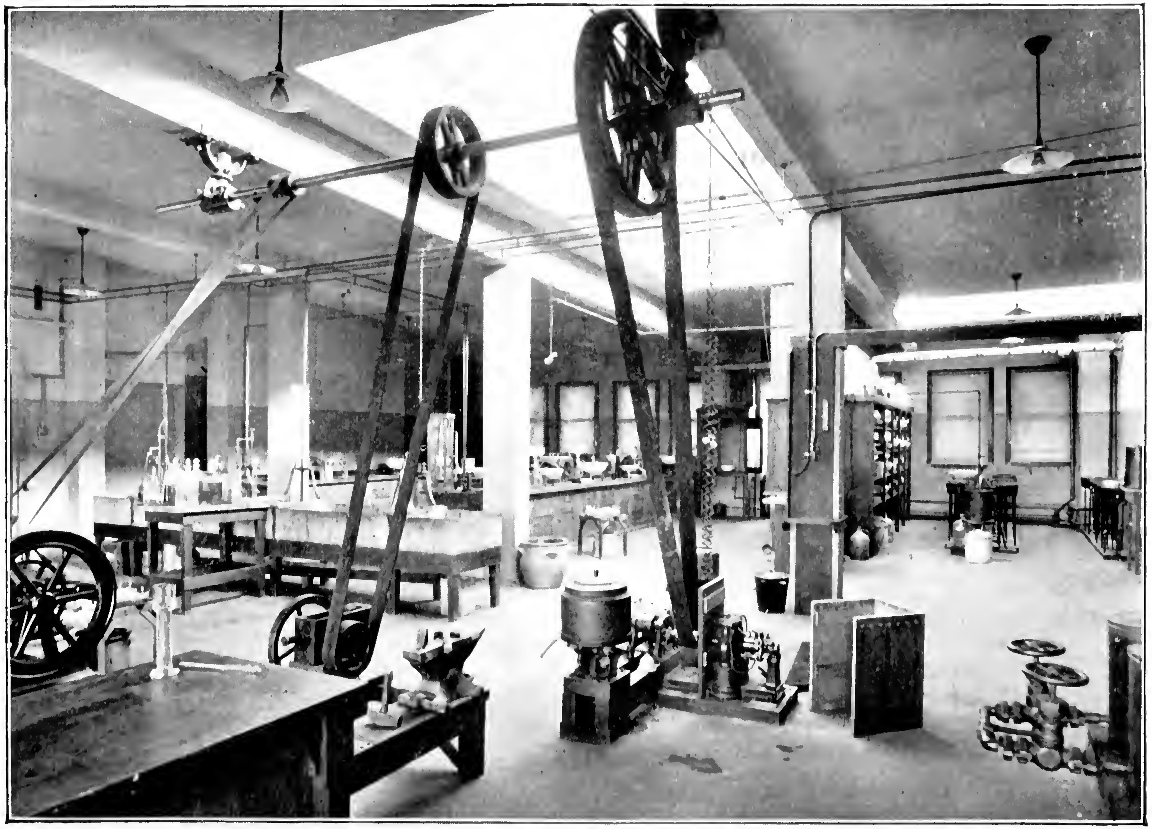
Research Laboratory of Physical Chemistry.

The new Research Laboratory of Physical Chemistry consists of a series of seven small laboratories, equipped with all facilities for chemical and physico-chemical work — with enamelled thermostats, 220-volt direct current circuits, steam-heated stills for preparing the purest water, hot closets, steam baths, systems for distributing distilled water, gas, and air blast, well-ventilated hoods, and other conveniences. Adjoining these laboratories is a number of other rooms devoted to special purposes, such as optical measurements, photography, weighing, tool work, and the storage of chemicals and apparatus. A skilled instrument maker, a stenographer, and a laboratory assistant are engaged in the service of the research staff.

The researches are under the charge of those professors of the Institute who are connected with the subject of physical chemistry, and are carried out in part by a salaried staff of research assistants



LABORATORY OF WATER ANALYSIS.



LABORATORY OF INDUSTRIAL CHEMISTRY.

and associates consisting of ten members, and in part by fellows and graduate students who are candidates for advanced degrees. A considerable number of seminar and lecture courses upon selected topics of physical chemistry are given each year by members of the research staff, and these are attended by all the workers in the laboratory, whereby the danger of too great specialization is avoided.

The following statement of the investigations that have been pursued during the year 1903–4 will show the character of the work already in progress. Three separate researches have been devoted to the study of the electrical conductivity of aqueous solutions at high temperatures and pressures. These investigations have served to throw much light upon the change of physical properties through wide ranges of temperature, and upon the chemistry of dissolved substances under these unusual conditions. Investigations are also being carried on upon the electrical conductivity of fused salts; upon that of very dilute acids and bases; upon the migration of ions during electrolysis; upon the hydrolysis of ammonium sulphide in solution; upon the dissociation-relations of sulphuric acid; and upon the coagulation and migration of colloidal substances. Finally, work, which has been in progress for some years, has been continued upon the development of a new system of qualitative analysis, which shall include nearly all the metallic elements.

The work of this laboratory, in which the Institute has taken the unusual step of establishing a special laboratory devoted entirely to research, not only promises to be of very great importance to the advancement of science, but is sure to raise the standard of instruction in the Institute itself.

The Augustus Lowell Laboratories of Electrical Engineering.

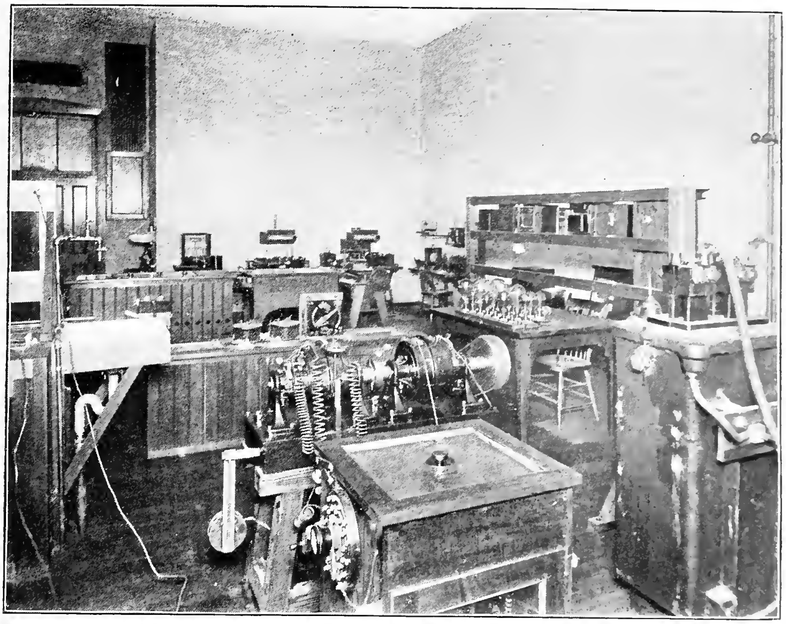
Since the beginning of the year 1902–3 the Department of Electrical Engineering has been located in the new Augustus Lowell Laboratories of Electrical Engineering erected during the summer of 1902. These cover an area of about 45,000 square feet; and, in addition to lecture-rooms, include a laboratory of electrical testing, photometer-rooms, a number of research rooms, and a main power and testing floor,

300 feet in length by 40 feet in width. With its unusual equipment the new laboratory offers facilities for instruction and research which are believed to be unsurpassed either in this country or abroad.

In addition to a considerable variety of direct and alternating current apparatus, there is a complete lighting and power plant capable of supplying all the buildings of the Institute. This plant consists of boilers, direct-connected generators, a surface-condenser and a cooling tower, the necessary circulating pumps, and a feed-water heater. The output of the generators is delivered to a switch-board of modern type and may be distributed to the various buildings or delivered to mains running throughout the laboratory. With this plant the students may make tests to determine the actual cost of the generation of electrical power, taking into account all the factors, from the cost of coal. Tests of the plant are being carried on this year and the results are discussed in general conferences from both the mechanical and the electrical standpoint.

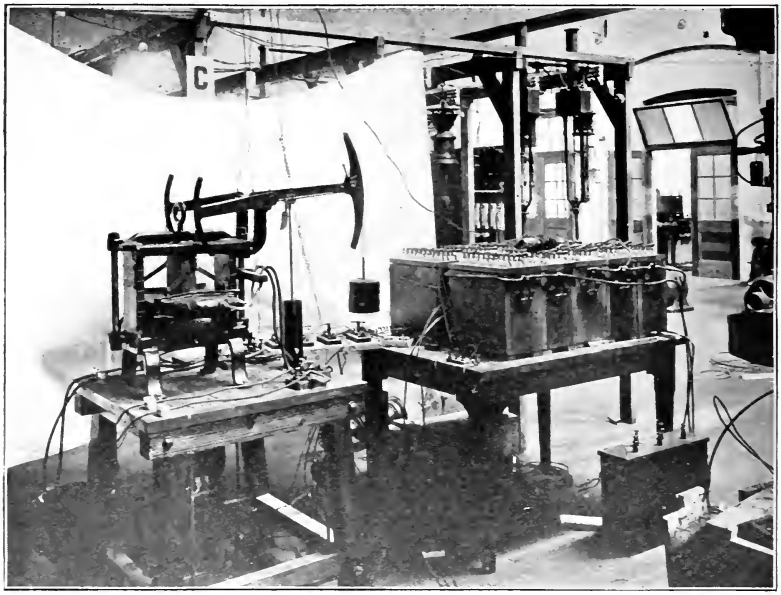
The power plant, the equipment of the standardizing laboratory, and the great amount of auxiliary apparatus are fully described in the annual Catalogue. The whole laboratory equipment has been selected with special reference to its usefulness for purposes of instruction. Although it of necessity comprises many large machines, yet the attempt is made to keep the laboratory units small. In this way only can a large number of different types of apparatus be obtained with a reasonable expenditure. The machines, however, are all of a size to illustrate the working characteristics of the particular type in question.

The instruction is planned to give the student at first an idea of the principles of operation of each type of machine as a unit, its efficiency, regulation, and general characteristics. Afterwards the machines are combined in a more or less complicated system to illustrate the broader principles of engineering operations. The student thus gets a clearer idea of the relations existing between the parts of a commercial system than would be possible in a laboratory where only individual units were used. In arranging and shifting the apparatus the ten-ton, electrically driven crane, which travels the whole length of the laboratory, is brought into use.



STANDARDIZING LABORATORY.

THREE-PHASE INDUCTION MOTOR, ARRANGED FOR THESIS WORK



CONSTANT CURRENT TRANSFORMER.

THESIS INVESTIGATION OF OIL SWITCHES.

As an illustration of the problems sometimes undertaken, there is being constructed this year, in connection with thesis investigation, an artificial transmission line, to be used later in the laboratory instruction. After tests have been made upon individual types of generators and motors, these will be combined with the transmission line to illustrate some of the principles of high voltage power transmission, such as the relation of motor capacity to line constants, the effect of line unbalancing, and the influence of varying the capacity and inductance. All such grouping of apparatus as this tends to broaden the point of view of the student. It cannot, of course, supply the place of that actual practice which must come after graduation, and is not designed to do so, but, when supplemented by conferences on the broader principles involved, this practice may give the student a much more comprehensive view of the bearing of his experiments upon current engineering practice.

Throughout the work of this laboratory, as everywhere in the Institute, the student works in small sections under the careful supervision of the instructors. Before beginning his work he is required to present a statement of its object, the method of attack, the apparatus and instruments necessary, and a sketch of the arrangement of circuits for carrying out the investigation. This plan is commented upon by the instructor and is then turned over to the student to be worked out by him individually. He is expected to get the apparatus in shape and to connect the circuits, and in many cases to construct such small pieces of apparatus as he may require, especially in thesis work. Throughout all the laboratory instruction such independence of action is encouraged and insisted upon, and in addition the importance of original investigation is strongly urged. For such research, the facilities of the Lowell Laboratories are unusual.

The Biological Laboratories.

The Biological Laboratories occupy nearly the whole of one floor of the Henry L. Pierce Building and are so arranged as to afford opportunities not only for the instruction of beginners in microscopy, general biology, zoölogy and botany, but also for others in bacteriology, industrial biology, and experimental physiology. Most im-

portant of all, perhaps, is the Research Laboratory, provided for the use of advanced and graduate students and the younger instructors.

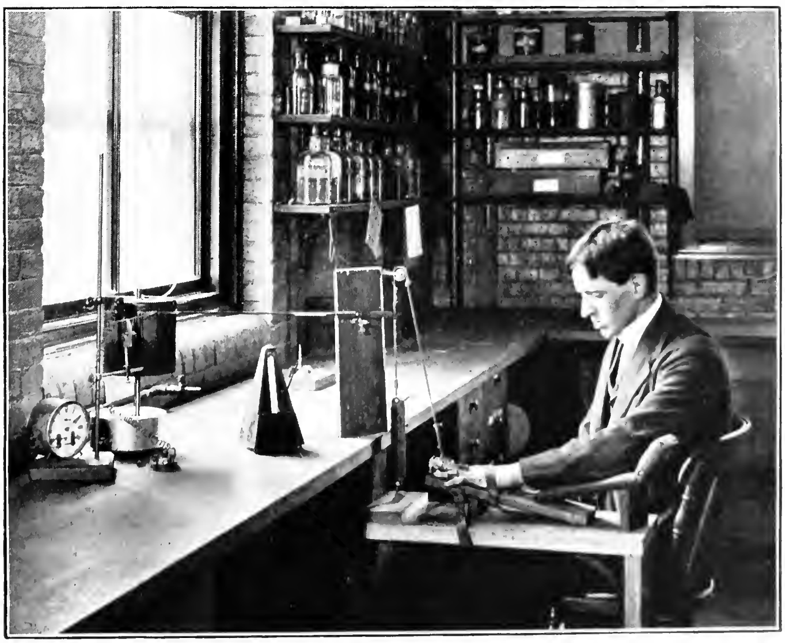
The Second Year Laboratory of General Biology is a large room accommodating about forty students and furnished with work tables, low-power microscopes, electric table-lamps with flexible standards, for microscopic and especially dissecting work; as well as with lockers, supply cases, lecture table, blackboard, specimen cases, etc. By the use of prismatic glasses in the upper sashes of the windows, this laboratory, as well as all the others in this department, secures a particularly serviceable light, even in that part of the room remote from the windows.

In this laboratory beginners in general biology, general botany, microscopy and other elementary subjects are taught how to use the microscope, how to prepare simple "mounts," how to dissect plants and the lower animals, how to keep a laboratory note-book, and how to describe orally with fullness and accuracy what they actually do, or what they see through the microscope. Experience has shown that training of this kind is of service in every walk of life, while for those who intend to pursue more advanced and more specialized branches of biology, the training here acquired is indispensable.

In the third and fourth years of the Course in Biology students work almost constantly in the Laboratories of Comparative Anatomy, Histology and Physiology, arranged to meet their special needs. In the former, convenient and well-lighted dissecting tables are provided, as are also the materials and apparatus necessary for section-cutting and microscopical work; but in the latter a very different arrangement prevails, tables being provided with reference to the arrangement of measuring apparatus, smoked drums, kymographs, and the other apparatus of a well furnished physiological laboratory for experimentation, and instruction and research.

In the Bacteriological Laboratory also the arrangements and appliances are such as the special work to be done requires. High power microscopes, glass dishes for the cultivation of bacteria, nutritive media, incubators, thermostats, stock cultures, and the

PHYSIOLOGICAL WORKSHOP.



PHYSIOLOGICAL LABORATORY. THE ERGOGRAPH, USED IN STUDYING NEURO-MUSCULAR FATIGUE.

PREPARATION ROOM ATTACHED TO THE BACTERIOLOGICAL LABORATORY.

CULTURE ROOM, FOR SAFE KEEPING OF PURE CULTURES OF YEASTS, MOLDS, AND BACTERIA.

other paraphernalia of the modern laboratory of bacteriology are at the service of the classes.

Places are provided in the Research Laboratory for fourteen workers, who are expected to follow largely their own bent in the solution of new problems or the verification of such work of others as requires confirmation. This laboratory, receiving light from the northeast and the southwest, is particularly adapted for microscopical and other work upon minute objects, and, as it has recently been rearranged and fitted up with the latest and most convenient forms of incubators, culture chambers and other appliances, it is particularly favorable for research work of an advanced grade.

By means of an efficient staff of teachers and by careful supervision and control these several laboratories are coördinated in their respective functions so that the beginner advances in an orderly and natural way from the first to the last and, if his progress is satisfactory, gradually acquires a training and a point of view calculated to develop his common sense, industry, perseverance, and accuracy. If, by good fortune, he possesses also independence and originality, the very best results may be reached.

Sanitary Research Laboratory and Sewage Experiment Station.

More closely connected with the Biological Department than with any other are the Sanitary Research Laboratory and Sewage Experiment Station of the Institute, established and supported by a friend who for the present prefers to remain anonymous. These are located on Albany Street, opposite the Diphtheria Ward of the Contagious Diseases Department of the Boston City Hospital, and in close proximity to one of the largest sewers of the city, from which fresh sewage can be obtained with ease at any hour of the day or night. The laboratories are chemical and bacteriological; and the station is experimental, furnished with a series of large tanks and filters for the practical study of sewage purification, such as intermittent filters, septic tanks and contact filters, trickling and aerobic filters, etc., the whole constituting a very valuable and altogether novel addition to the educational facilities of a great modern technical

school in sanitary engineering. It is doubtful if any other educational establishment possesses a practical adjunct of this kind, illustrating its more theoretical instruction in municipal sanitation by practical processes of sewage purification accessible for experimental and testing purposes to every qualified student.

Physics.

The Rogers Laboratory of Physics has an unusually extensive equipment of apparatus for both demonstration and physical measurements, and large additions are made to it every year. The several laboratories are as follows: — The Laboratory of General Physics is devoted to instruction in general physical measurements, including mechanics of solids, liquids and gases, light and heat. The equipment consists entirely of instruments of a high grade, and corresponding precision is required in the work of the student. Among the more novel pieces of apparatus in general use may be mentioned a Zeiss comparator, spherometer, and thickness micrometer, a fine Zeiss spectrometer, and a comparator from the Société Génevoise.

The Electrical Laboratory is provided with electric circuits for both direct and alternating currents. It contains an extensive collection of electrical measuring apparatus for the determination of current, potential, resistance, capacity, inductance, wave-form, and the magnetic properties of iron. The apparatus has been selected with a view to instruction in measurements of fundamental importance and approved value.

The Physico-chemical Laboratory is fully equipped to give instruction in physico-chemical methods and for research work in chemical physics. Among the special pieces of apparatus may be mentioned a Berthelot platinum calorimeter, a large Landolt-Lippich polarimeter, an Abbé dilatometer and heater, with complete quartz accessories, a Zeiss refractometer and comparison spectroscope, and Nernst's and Drude's apparatus for dielectric constants. A large electrically heated thermostat, the temperature of which can be maintained constant to within a few thousandths of a degree, is provided for work in chemical statics and chemical dynamics. Work in thermo-chemistry, chemical statics, and chemical dynamics, is required in connection with the lectures on these subjects.

The Electro-chemical Laboratory provides for instruction both in electro-chemical measurements and in applied electro-chemistry. The laboratory for the former work has been equipped with every convenience and facility for carrying on electro-chemical experiments. Each student is given a large desk provided with four circuits of 2, 12½, 25, and 110 volts, from each of which currents up to 10 amperes can be taken at all times. An adjustable rheostat of corresponding capacity is also provided and wired directly to terminals on the switch-board at the front of each desk. Water, gas, and suction are provided at one end of each desk, and a large electrically heated and regulated thermostat at the other. In addition to the usual apparatus required for chemical work, each student is given a very complete equipment of electro-chemical apparatus.

The work in applied electro-chemistry is intended to illustrate, on a fairly large scale, the more important industrial processes involving the mutual transformations of electrical and chemical energy. For this work a special laboratory adjoining the preceding has been equipped with a 25-kilowatt, double-current motor generator, which may be connected to give 1,000 amperes at 25 volts or 2,000 amperes at 12½ volts. This generator supplies the students' desks with 12½ and 25 volts, and also the electric furnaces for electrolytic reductions on a large scale. For electric furnace work requiring heat alone the laboratory is also provided with alternating current at 1,000 volts, which, by means of a special 50-kilowatt transformer designed in the department, is stepped down first to 160 volts and then in steps of ten volts each to ten volts.

The Laboratory of Heat Measurements is devoted to the study of accurate thermometry, the measurement of high temperatures, the determination of the efficiency of fuels, and the study of intense sources of heat, such as the electric furnace. It is well equipped with standard apparatus for these purposes, and contains also much original apparatus, especially that in use for the technical measurement of thermal conductivity and for the regulation and control of high temperatures. There is also apparatus for the determination

of the mechanical efficiency of explosions and for the study of the velocity of propagation of explosions. The Laboratory of Acoustics is especially designed for experimentation and research on sound and its applications, including the acoustic side of telephony. It contains an excellent collection of standard forks and other acoustic apparatus. The Optical Laboratory provides facilities for students to familiarize themselves with the more important optical methods and instruments now in use. Facilities are offered for advanced work in spectro-photometry, and for work in photography, for which special dark rooms are provided.

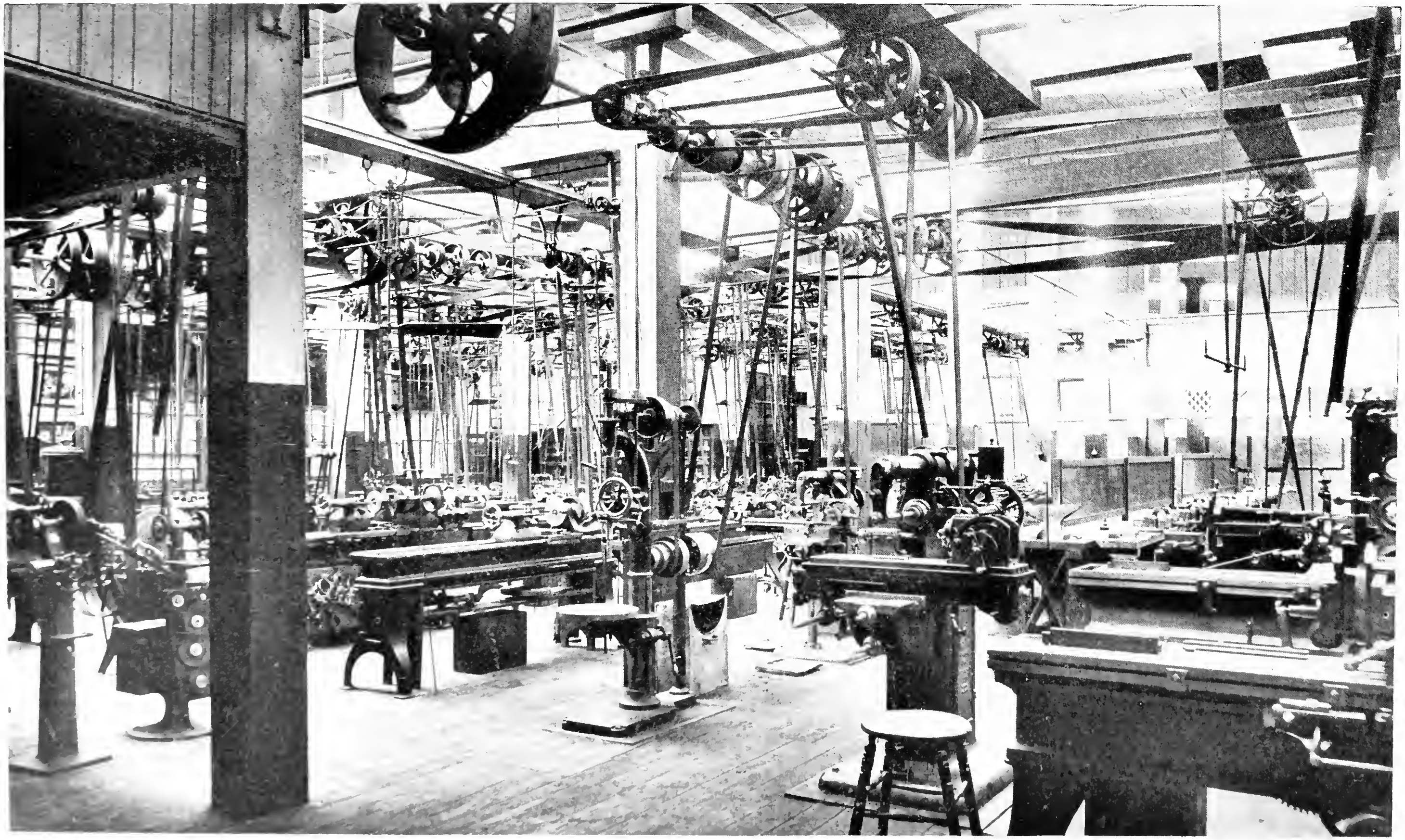
The Geological Laboratory.

The Geological Laboratory embraces laboratories of mineralogy, lithology and structural geology, and economic geology, provided with apparatus, models, and charts for the study of crystals and geologic structure. An extensive collection of specimens forms part of the equipment,— minerals, series of rocks in trays and in thin sections for use under the microscope, illustrations in structural geology, a collection of dressed blocks of building and ornamental stones, and an extensive series of ores and other economic minerals. A separate room is used for blowpipe work in determinative mineralogy.

The geological library contains about thirteen hundred bound volumes and several hundred pamphlets; and also the current numbers of leading serial publications. In the historical laboratory of geology are two hundred drawers of specimens of fossils and rocks, stratigraphically arranged. There is also an exhibition case of specimens arranged in like manner, and a case of eighteen large drawers filled with maps, sections, and drawings. Here instruction is given in stratigraphical palæontology; and here, also, geological maps and sections are drawn, field notes revised, and the results of investigations prepared for final presentation.

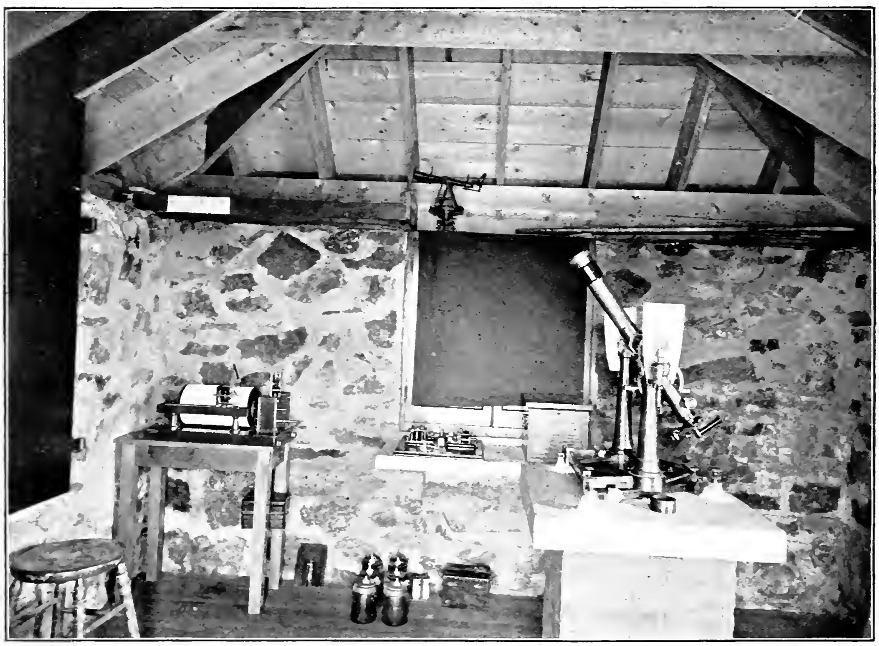
The Mechanical Laboratories.

The Mechanical Laboratories of the Institute were founded in 1876. In 1883 a new and extensive equipment was provided, covering about twenty-four thousand square feet of floor space. These laboratories were the first established in this country to give instruction by the Russian method, which has as its aim the systematic instruc-



PORTION OF MACHINE TOOL LABORATORY.

THE GEODETIC OBSERVATORY.



INTERIOR OF THE OBSERVATORY.

tion of the student rather than construction. Instruction is now given in carpentry, wood turning, pattern work, foundry work, forging, chipping and filing, and machine-tool work. The aim of the several courses is a systematic training in the fundamental typical operations to be performed with the tools and appliances suited to each art, including instruction in the methods of sharpening and adjusting all edge tools used, with a discussion of the proper cutting angles, speeds, and feeds for the various materials worked. Attention is also given to the principal properties and characteristics of the materials used in each art.

Instruction in each course is given by means of a series of projects or models in which the systematic training and advance of the student, precision, the cultivation of the powers of observation, judgment, and foresight, and orderly habits are the main ends sought. The instruction is mainly oral, each new operation being described and discussed just before the work is to be undertaken. As a rule the entire class is engaged upon the same or similar projects, and all work is executed from suitable working drawings.

The engineering students enter these laboratories for the purpose of acquiring mental as well as manual training; they also incidentally acquire a knowledge of the practical methods of construction, which is of great value to the designer. With this in view the student is not required to repeat work sufficiently to become expert, but ample practice is given to enable good work to be done in a reasonable time. When a piece of work is brought to the standard in respect to dimensions, fit, and finish, another more advanced project is started, comprising elements already acquired combined with others which are new. Useful projects are introduced whenever they are consistent with the systematic arrangement of the exercises.

A detailed account of the equipment will be found in the annual Catalogue. The laboratories are used chiefly by the students in Mechanical, Chemical, Electrical and Sanitary Engineering, and Naval Architecture. During the year 1903–04 two hundred and six students in all were taking instruction in wood-working, one hundred and thirty-two in forging, one hundred and sixty-four in

chipping and filing, and one hundred and seventy-five in metal turning and machine-tool work.

No account of the equipment of the Institute would be complete without mention of the complete facilities for their respective lines of work possessed by the Departments of Architecture and of Civil Engineering. Since 1883 the Department of Architecture has changed its location three times, to meet the demands of increasing classes. Instead of the original small quarters on the upper floor of the Rogers Building, it now occupies two and one-half floors in the Pierce Building, besides a large room for modelling in another building. The drawing-rooms accommodate over two hundred students. The department has a magnificent library and a very large collection of photographs and lantern slides.

The Architectural Drawing-rooms.

The drawing-rooms of the Departments of Civil and Sanitary Engineering occupy the two upper floors of the Engineering Buildings A and B, and have desk accommodation for two hundred and forty-five students. For instruction in geodesy and astronomy there is a geodetic observatory, situated in the Middlesex Fells, within easy reach of Boston. It is so placed as to be well protected from disturbances in magnetic experiments. It is equipped with a transit instrument, a sidereal chronometer, a chronograph, a magnetometer, a dip circle, an altazimuth instrument, and many smaller appliances. In this observatory students have opportunity to become familiar with the most refined methods of determining latitude, longitude, time, and azimuth. Observations are also made with the magnetic instruments, the conditions for this work being especially favorable. While the observatory is chiefly for the use of graduate students in geodesy, it is also used by regular students in civil engineering. All students taking the advanced course in astronomy have practice in the use of the astronomical transit and the chronograph in making observations for determining time.

The Geodetic Observatory.

CONCLUSION.

IN conclusion a word of general summary may be added with regard to the work of the school. The Institute is at once a college and a professional school. Students come to it at eighteen years of age, with such preparation as can be obtained in the public high schools. They receive first a year of general drill, mainly in mathematics through analytic geometry, in chemistry, and in mechanical drawing. A preliminary choice of professional course is made at the middle of the first year, but divergence is slight until the beginning of the second year. In the second year, physics and calculus are common to most Courses, and elementary professional subjects are undertaken; for example, surveying for students in civil engineering, mechanism for those in other engineering Courses, and qualitative and quantitative analysis for those in the chemical Course. In the third year a large proportion of the time, and in the fourth year nearly the entire time, is devoted to professional subjects.

General Outline of Courses.

Throughout all Courses three principles are kept constantly in mind. The first is a close personal relation between students and instructors, in order that the needs and capacities of students may be accurately gauged, that faults may be corrected, and that good habits may be formed. This requires the division of classes into numerous small sections for recitations, with proportionately less dependence upon the results of final examinations. The second principle is the careful adjustment of theoretical and experimental work in the courses of instruction, so that the work of the class-room shall prepare the student for that in the laboratory, while his laboratory work in turn shall serve to fix methods and results in his memory, and to give him capacity for further experimentation. In the third place, the importance is felt of guiding the student rather than merely instructing him. The function of the teacher, it is believed, is not so much to impart formulated knowledge as to develop

Characteristics of Instruction.

the power of ascertaining facts and overcoming difficulties. To this end the student is trained to work with less and less dependence upon his teachers, until in his final year he is required to prepare a thesis, which is usually the result of considerable research.